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THE ORIGIN OF SPECIES IN SOCIOLOGY.

By J. Collier.

Sociological species consist of family types, forms of government, industrial and ecclesiastical organizations, games and sports, manners and fashions, languages, sentiments and beliefs, philosophies and sciences, literatures and arts. They possess all the characters of vegetal and animal species, and have the same kind of reality. They transmit those characters from generation to generation. They yet develop in definite directions, from a less to a greater degree of perfection. They have a local habitat, even when it belts the world. They battle with one another for existence, and the fittest survive. They have likewise peaceful intercourse with one another, and exhibit all the phenomena of cross-fertilisation. What concerns us now, they spring up as new species of animals and plants spring up. The law of constant variation in all species and in every organ is as operative in sociology as in biology. Some slight accidental or involuntary modification of an existing usage hardens into a practice, from individual and private becomes public and general, and in course of time assumes a shape wholly unlike its first form, and perhaps contrary to the intentions of its originator. We shall give a few examples from various branches of sociology:—

1.—The origin of the feudal system, as it has been infelicitously termed, was the crux of constitutional history throughout last century. Reeves, the historian of English law, asserts that two statutes enacted by William the Conqueror definitely established it all over England. That is an example of the doctrine of special creations in history. No accredited writer would now express himself so loosely, but it is a specimen of hundreds of opinions that still prevail about the origin of social institutions. When the theory of special creations has been dislodged, its place is taken by the hypothesis of social deluges and cataclysms. The eminent German or Germanising writers who have lately reconstructed the constitutional history of the Middle Ages—Waitz, Roth, von Maurer and Sohm, Freeman and Stubbs—explain the origin of sociological species as Cuvier explained the origin of animal species. Feudalism was the outcome of what a scholar like Brachet, with the uniform development of the French language before his eyes, does not hesitate to call "the inundations of the fifth century." The invading Germans took possession of Gaul, England, Spain, and northern Italy as conquered countries. In each they found thousands of farmers in occupation of the soil. Exercising the right of eminent domain claimed by all conquerors, they confiscated the entire fee simple, and converted the occupiers into serfs. Certain usages, the benefice and companionship, were transported bodily from Germany, and formed the pillars of the new social system. A whole set of national institutions was submerged, and a complete new set was founded on their ruins. To the anthropologist and the antiquarian this revolutionary theorising has long been a stumbling-block, and to the sociologist foolishness. The new school maintains, on the contrary, that there were no real invasions. Small commandoes (sometimes coalescing) filtered across the frontiers and slowly blended with the native populations. There were neither victors nor vanquished. The Germans came on the invitation of the Roman rulers, and were gradually Romanised. They scarcely changed the ethnical composition of the various peoples, but at the most reinforced the blonde long-headed element. The political transmutation was slow and imperceptible. No new *régime* was founded. There were no radical changes in the status of persons or property. There was no expropriation. Nevertheless, between the fifth and the ninth centuries, a slow transformation of manners, usages, and ideas took place throughout western Europe. Founded by no public laws or degrees, but built up stone by stone as the result of hundreds or thousands of isolated private acts, turning insensibly into habits which were at length firmly rooted, that astonishing feudal structure was reared which it took the energies of a whole people to overthrow in 1789.

We can here follow this very complex evolution only along a single line. What was the origin of one of the most characteristic features of feudalism—medieval serfage? No article of the Digest, no law of the Codes, no account by any historian records its birth. Serfage was formed slowly, obscurely, and without being observed. It began as a slight variation of existing usages; its first rudiment was a tiny germ deposited in the bosom of ancient slavery? The late Fustel de Coulanges detected its rise in a brief statement made by an ancient Roman writer on agriculture. The voluminous Varro alleges that the master who was satisfied with a slave sometimes granted him a piece

of land, together with a flock of sheep or a herd of cattle. A Servian story of Sacher-Masoch's suggests that such a donation may sometimes have been made as the dowry of a discarded mistress. Varro adds (and the addition is important): "bestow on him this boon; he will be the more firmly bound to your domain." This short reference contains in summary the chief rules of medieval serfage. The slave was allowed to live apart, to till the field that had been assigned him, to tend his flock or herd. He was still obliged to labour on his master's estate some days in every week; and this provision differences Roman serfage from Greek or German, but identifies it with medieval serfage, and seems to prove the affiliation. The rest of the time the slave, thus segregated from the troop, was his own master, he was to that extent a serf, no longer a slave, his plot was held by a tenure.

The serf, whose humble beginnings we thus witness, soon acquires a more defined status. The jurists of the second and third centuries mention the slave who pays a due to the proprietor, like a farmer. Ulpian even names him a quasi-farmer. The jurist Paul signalises the slave who tills land at his own risk, and pays a rent fixed in advance. Two other jurists speak of a "lease of land" made to a slave.

The status of the individual was not changed. He was still legally a slave. He had no rights as against the master; the plot could at any time be resumed. At his death the owner did resume it. The slave's children could not inherit it. Nevertheless, the master found it to his advantage to leave the slave in occupation of it; he worked harder on land that was almost his own, and it yielded a larger return. When the slave died, it might be also to the master's advantage to leave his family in possession of it. The servile tenure would thus become permanent, and almost hereditary.

At the end of the third century a new step was taken. A fresh roll of all throughout the empire who were liable to pay the land-tax was compiled. Finding many slaves settled on land, and residing in houses by themselves, the enumerators enrolled them as *servi ascripti*—inscribed or enrolled slaves—the manifest ancestors of the "serfs ascribed to the glebe," or serfs of the soil, who bulk so largely in the medieval rolls. To register them, though it may have increased their burdens, was to make a legal recognition of their status, and give them a title to the occupation of their land. The law took another step: it forbade a master to sell his slaves unless at the same time he sold the land which they cultivated, nor could he sell his land unless he sold his slaves along with it. A family of slaves was thus allowed to live for several generations on the land originally assigned to them; insensibly they came to be looked upon not as slaves of a master, but as serfs of the soil. It was a great advance. The serf had a house of his own and a family. He was almost a freeman, and might well believe that he was one.

Cultivators of this class doubtless received large accessions as the German immigrants crowded into Gaul. Many also of the smaller proprietors and of the diminishing number of free farmers may have been degraded to serfs. But the change was one of degree; there was no revolution. The new status had originated in Roman times, and only developed as it expanded.

2.—How two radically different social species may branch out from a single stem is well illustrated by a century's growth of the British and the American constitutions. In the last quarter of the eighteenth century these two were substantially alike. The constitution of the United States is known to have been modelled on that of England, but less, as it might have been observed, in its practical working than as it was theoretically expounded. There were two visible differences, of no apparent magnitude, and from these two small variations descend a whole host of differences that have made the two constitutions as mutually unlike as are the constitutions of Germany and Russia. First, the American Executive and the Legislature were rigidly separated. This was partly intentional, but it involved the absence of the Ministry from the legislative chambers, and this was so far from being designed that, after the constitution came into operation, it was for some time debated whether Ministers should be present in either House. It was decided to exclude them, and the exclusion has reacted equally on the Executive and the Legislature. While the English Executive has gradually become the nation acting, and the English Parliament has been slowly transformed into the nation legislating, the Legislature and the Executive in the United States have year by year been drifting further away from identification with the people. The realisation of abstractions has proved as fatal in politics as in philosophy. The Executive acts like an independent organ, and is sometimes (as under Johnson) in flagrant opposition to the popular will, or (as under Cleveland) in but partial sympathy with it. The Legislature has likewise developed along lines of its own. Occult and irresponsible standing committees have bit by bit wrested from Congress the entire power of legislation. In 1790, to obviate some practical difficulties, the House of Representatives assigned the nomination of these committees to the Speaker. This innocent-looking provision made that functionary a true dictator, wielding a more absolute authority than the Czar, while the committees may be compared, for their secrecy and autocracy, to the Venetian Council of Ten. A loyal American, Eugene Schuyler, defines the government of his country as an absolute and irresponsible despotism exercised, under the mask of constitutional forms, by half-a-dozen individuals—the President and two of his ministers, and the Speaker and two chairmen of his nominee committees; in fact, by two individuals.

Nor is this all; a second original variation has been as fruitful of consequences. The President of the Republic, the counterpart of the King, had necessarily to be elected, and the method of election gave rise to the nominating convention. The establishment and growth of this convention are held by so high an authority as E. L. Godkin to "constitute the capital fact of modern democracy in America." Yet there is no record of its origin. None of the earlier or later writers on the constitution allude to it. It was hidden from profound observers like Tocqueville. It came without observation, and grew up in silence and darkness. Its influence was masked in the forties and fifties by the overpowering personalities of Webster, Clay, and Calhoun, who seemed to thwart its behests, and were yet, all of them, its victims. During the excitement of the anti-slavery conflict it was but the minister of the popular will. After the war was over it rose into prominence and power. Step by step, it laid an iron grasp on all the machinery of government, and nominated the President, Vice-President, and the federal legislators, the governors and legislators and officers of the states. It was itself then transformed, and, having been omnipotent, it became impotent, surrendering its prerogatives to "the machine," which abandons them to the boss. In most of the states, and in all the larger cities, the boss is king. Here is a second metamorphosis which, together with the first, has made the working constitution radically different from the constitution on paper, and thus created a new political species.

3.—The modern newspaper had a twofold origin. It was a continuation of the manuscript letters composed

by professional gossips, and circulated in the provinces, as these letters were the expansion and regularisation of family and coterie letters that had been circulated beyond their first destination. It was also an incorporation of the placards from which people all over Europe derived their knowledge of trade, commerce, amusements, and the odds and ends of life. These soon acquired (at least in France) a vehicle of their own—a printed sheet that was circulated gratis or among subscribers, as merely advertising journals, like the *North British Advertiser* were circulated forty years ago. In course of time the two were amalgamated, and together they formed the advertising and literary halves of the modern journal.

The solitary journal produced by antiquity had a similar genesis, yet not quite the same. The circular letter was rather its midwife than its parent, and the poster from which it really descended was not the popular but the official placard. The part that placards or inscriptions played in the old Roman world is well known. They were the chief organ of publicity. There the emperors inscribed their rescripts, the Senate its laws, and the magistrates their decrees; on them the citizens witnessed their piety towards the gods, their devotion to their sovereigns, and their gratitude to their benefactors; religious corporations thus recorded their fulfilment of their vows, and private individuals registered their contracts. They were graven on brass, marble, or stone, according to their dignity or importance. Over 120,000 of them have been discovered, and by their means historians have revived the life and reconstructed the constitution, the laws, and the religions of the empire. On walls whitened with chalk more perishable memorials of the daily life of the people were traced. It should seem that, in order to create the Roman journal, some enterprising Renaudot (as happened in France) had but to copy and collect the posters of the day. No such evolution took place. Not till B.C. 59, when Julius Cæsar, who had just been elected consul, directed that the minutes of the meetings of the Senate and of the assemblies of the people should be daily placarded, do we find any evidence of the existence of a journal. The *Roman Gazette* was this poster reduced to writing. Educated slaves or freed men many of them Greeks—the ancestors of our reporters—went everywhere in quest of the news eagerly sought for by officials and citizens absent in the provinces. These, it is presumed, were the copyists of the official placards posted daily in the Forum by order of the first and greatest of the Cæsars. By means of the Imperial post the rolls were spread over the vast surface of the Roman world. They were greedily read, and were copiously used by naturalists and historians like Pliny and Tacitus. From fragments of it scattered through Latin writers, Hübner and Boissier have put together that oldest of newspapers, as a naturalist builds up an extinct species. Now mark its evolution. At first solely a report of proceedings in the aristocratic and popular branches of the Roman legislature, as we may call them, it next included the letters and speeches of the emperors and the decrees of the magistrates. A semi-official portion, resembling our *Court Circular*, and mentioning such facts as Cæsar's refusal of a crown and the Imperial receptions on the Palatine, was speedily added. It was soon swelled by accounts of such portents and incidents as a shower of bricks in the Forum, the fidelity of a dog to its master, the suicide of a charioteer, public benefactions, births, deaths, marriages, and divorces—the last at the rate of one per diem. Meanwhile, the original *raison d'être* of the journal had disappeared. The assemblies of the people ceasing to be held, of them there could be no report. Then Augustus forbade the minutes of the Senate to be published. Thus the accessory portion of the journal became its sole constituent, and the original design of the Dictator was both defeated and transformed. Out of a bald record of proceedings had grown a fair similitude of the modern newspaper. The name changed with the thing. At first, *The Acts of the Senate and the People*, it became *The Daily Acts of the Roman People*, and was currently referred to as the *Daily—diurna* or journal. It lasted as long as the empire flourished, but it was an example of arrested development, and it died without leaving offspring.

4.—Literary criticism is still a stronghold of the special-creation theory. So instructed a critic as F. Brunetière alleges that, at a determinable period, and, as it were, at a given signal, the sense of art entered into French literary productions and transmuted them. People wrote prose without art, like Comynes and Margaret; then, all of a sudden, they wrote it with art, like Rabelais. They composed verse naively, like Marot and Saint-Gelais; all of a sudden, like Ronsard, they composed it consciously and like artists. An accomplished dillettante, Th. de Wyzewa, presumably after Mr. Gosse, makes Lodge out to be the "inventor" of five distinct literary species. Similarly, the romance of real life is commonly believed to have sprung suddenly into existence with Defoe. There are sports in literature as among plants and animals, but the modern novel is a species with a long pedigree, which has been traced by a profound student of the English Renaissance—J. J. Jusserand. Its remote sources are the heroic romance and the tale, and it issued from the fusion of the two. In Malory's famous work there is all that we now look for in the novel except living characters and psychological analysis. Yet of the latter there is a glimmering in a dissection of the passion to which the novel owes its existence—the first (says Jusserand) to be found in the prose romance. With Lyly we leave behind us the romance of chivalry and approach the romance of contemporary manners. In "Euphues" the characters have some resemblance to real beings. The tone of conversation is not unsuccessfully imitated. Lyly's opinions on men and life and his analyses of the feelings are ill-fused with the narrative and exhibit the awkwardness of a first attempt, but they are there. The hero of the story is the direct ancestor of Sir Charles Grandison and *his* numerous lineage; and he anticipates, on nobility, love, and the education of children, the ideas that Richardson lends to his characters. Lastly, "Euphues" is the earliest example of that literature of the drawing-room and the parlour to which the contemporary novel is the chief contributor. Lodge and Greene continue the development. In Sydney's "Arcadia" dramatic power for the first time quits the stage and enters the romance. Gynecia is perhaps the first genuine creation in English prose literature. There is constant penetrating analysis of passion, or, at least, of the primary passion. From this story Richardson borrows the name of Pamela and a romantic situation in which she figures.

If Richardson is the lineal descendant of Lyly and Sydney, Thomas Nash is the direct ancestor of Fielding. He, first in England, narrated the history of the picaresque hero, who was born in medieval Germany as Master Reynard, grew up in Spain as Lazarillo and Guzman, came to perfection in France as Gil Blas, and passed over to England as Tom Jones and Roderick Random. With his imaginary characters Nash (like Thackeray) mingles historical figures, and he describes real places and scenes. He paints two or three portraits worthy of Callot or Teniers. Keen observation of humours and oddities makes him an ancestor of Dickens; like Dickens, too, he has the capacity of being moved as he

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writes. On many lines he is the forefather of the modern novel.

Yet we cannot help perceiving that between Nash and Defoe a whole century lies blank. Shall we say (with Jusserand) that there was only an interruption of fecundity, or (with Brunetière) that there was a breach of continuity? A physiological analogy or identity may throw light on the matter. Like the Australian River Darling, some of whose branches flow underground for hundreds of miles, and come to the surface at long distances only by means of artesian bores, the spiritual germ-plasm unwinds its chain through silent generations or centuries, embodying itself at rare intervals in some individual or production which is not so much the descendant of some earlier production or individual as, like them, the outcome of a common line of development.

5.—The philosopher withdraws to his garret, like Spinoza, or banishes himself to a foreign country, like Descartes, there to excogitate his speculations in silence and solitude. Does not his system spring Pallas-like from his brain, "born without sire or couples of one kind"? Not so. Both can be fathered on past thinkers, and related to the thought of their time. As a more modern example of spiritual transmission we will here briefly trace, after Littré and Paul Janet, the genesis of Comtism. The philosophy of Auguste Comte can be historically affiliated on Francis Bacon. What are the intermediate links? There is a large unbridged gap of a century and a half. Then, in the preface to the great *Encyclopédie* edited by Diderot, we find Bacon's ideas, his organizing genius, his prophetic spirit; it is the *De Augmentis* done into French, developed and expanded; and Bacon himself is there acknowledged as the inspirer of the work. But that preface was written by d'Alembert. From him descend two lines. His pupil and testamentary executor was Condorcet, and from him Comte derived his views on the philosophy of history and the development of the human mind. The other, more important and more fruitful, comes down through the founder of Saint-Simonianism. Saint-Simon alleged that his early education had been directed by d'Alembert. From d'Alembert he acknowledged that he gained the idea of all his scientific works. To him he owed his conception of the unity and organisation of the sciences; like him, he projected encyclopædias.

Now arises the variation. Saint-Simon broke away from the critical and negative philosophy of the eighteenth century, and believed that the time had come to found a constructive and organic philosophy. This philosophy he named the positive philosophy. In various writings he traced its lineaments. All the sciences have begun by being conjectural before being positive; they have become positive in the order of their increasing complexity; they have entered into public instruction as they have grown positive; physiology is on the point of becoming a positive science; ethics will become such a science when it is founded on physiology; philosophy will become such when it is founded on the general facts of the special sciences. Here are the germs of all the principal ideas of Comte—especially of the classification of the sciences and the law of the three stages. The latter was more fully developed by Saint-Simon, and Janet has skilfully followed its traces through a number of his works. In him, too, will be found the Comtist character of science as consisting in verification and prevision, together with other root-ideas of Positivism. Like Saint-Simonianism, Comtism began as a theory of the sciences, advanced to be a social philosophy, and ended as a religious brotherhood. We may well say: no Comte without Saint-Simon; as no Saint-Simon without d'Alembert, and no d'Alembert without Bacon.

THE QUAGGA; A MISSING LINK.

By R. Lydekker.

When the Dutch first colonised that part of Africa of which Cape Town now forms the capital, they found the country absolutely swarming with a great variety of species of large game and other animals, whose form and appearance were for the most part unfamiliar. As they themselves came from a land which had long since been stripped of the larger members of its fauna, it is possible that unfamiliarity with these prototypes was one of the causes which led to the indiscriminate and often inappropriate bestowal of the names of the large mammals of Europe, or compounds of the same, on the animals of the new country. What, for instance, can be more inappropriate than the transference of the Dutch name for elk (eland) to the largest of the Cape antelopes, unless, indeed (which is scarcely likely), the settlers were aware, that etymologically the word signifies, in its Greek original, "strength." Neither is hartebeest (stag-ox) much better, although wildebeest (wild ox) is by no means an unsuitable designation for the animals known to the Hottentots by the title of gnu. Bastard hartebeest, on the other hand, is a cumbrous and senseless name for the antelope the Bechuanas call tsessabe. And it is much to be regretted that the Boers did not see fit to adopt for South African animals the native titles they found ready to hand.

In two instances, and apparently in two instances only, so far as the larger animals are concerned, they did, however, adopt this practice. The first instance is that of the large and handsome spiral-horned antelope now universally known as kudu, a name which is certainly not Dutch, and is believed by Sir Harry Johnston to be of Hottentot origin, since it is unknown to the Kaffirs or other tribes who speak dialects of the Bantu language. The second case is that of the animal forming the subject of this article, which is now universally known as quagga, from a corruption of its Hottentot name quacha, pronounced by the natives as "quaha." Even in this instance, however, the Boers appear at first to have displayed considerable reluctance to adopt the native name, for they originally called the animal wilde esel (wild ass), in the same way as they christened its cousin, Burchell's zebra, wilde paard, or wild horse. Eventually, however, better counsels prevailed, and *Equus quagga* became known to the Cape Dutch by the aforesaid native name, while the wilde paard (whose early title still survives in Paardeberg) was renamed bonte quacha, or striped quagga. When, however, the true quagga became very rare and eventually exterminated, the prefix *bonte* was dropped from the Dutch designation of Burchell's zebra, which was henceforth known throughout South Africa as the quacha, or quagga, pure and simple. Hence much confusion, and possibly also a factor in the extermination of the species to which that title of right belonged. For as the name in question continued to be in common use in South Africa at the time the true quagga was on the point of extermination, it is quite probable that this may have been the reason why the attention of naturalists in Europe was not drawn to its impending fate while there was yet time.

According to the best attainable evidence the quagga appears to have become extinct, in Cape Colony, at any rate,* about the year 1865, at which date a specimen

* From the fact that a skin was purchased by the Edinburgh Museum in 1879, Mr. G. Renshaw (*Zoologist*, February, 1901) has suggested that the species may have survived in the Orange River Colony till about that date. I am informed, however, that the specimen was believed to be an old one at the date of its purchase from a dealer.

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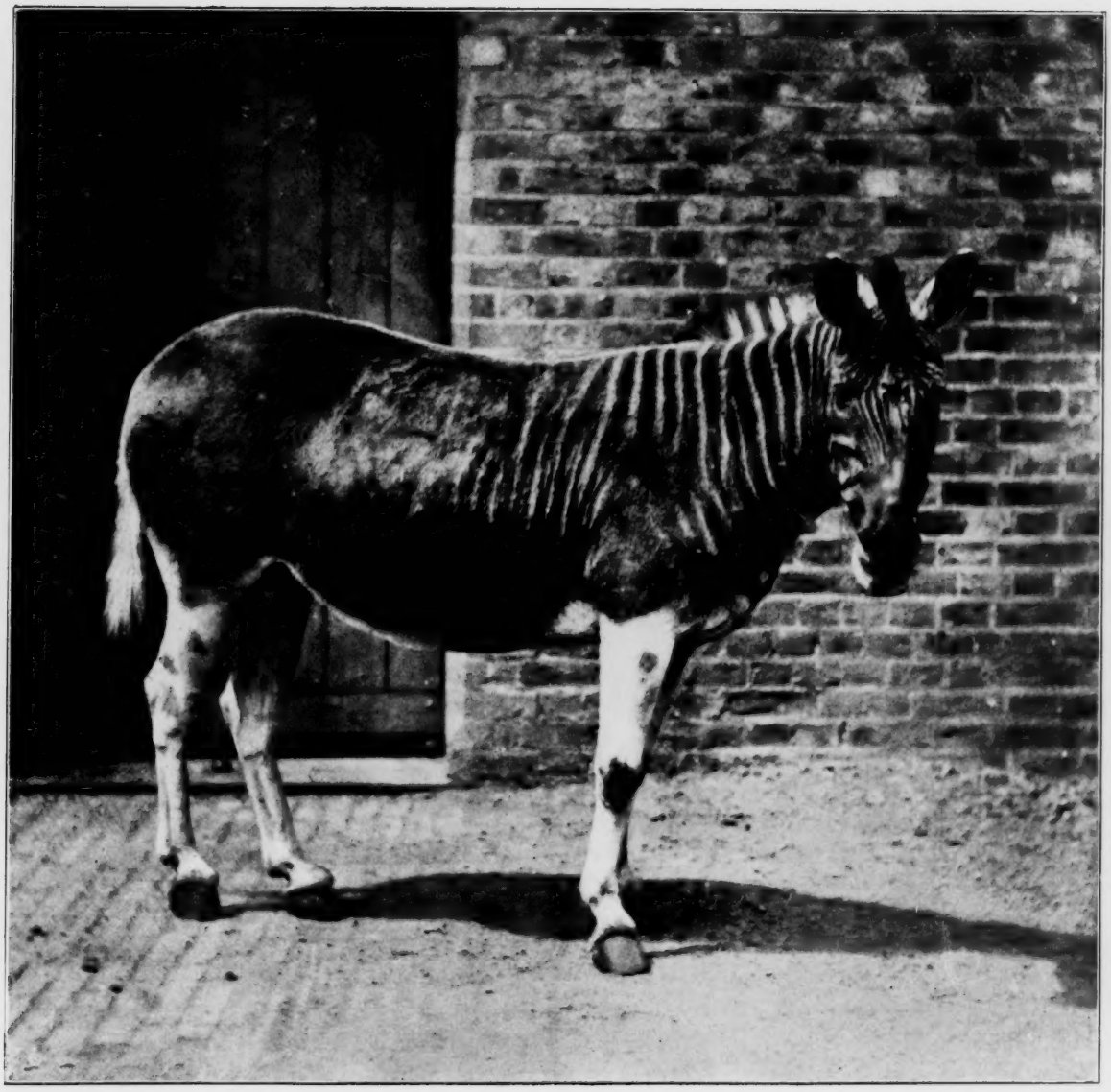

THE LAST OF THE QUAGGAS.

(From a Photograph by Messrs. York & Sons).

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was actually living in the London Zoological Society's menagerie; while another had died there only the year before. Of the latter example, a male, presented to the Society in 1858 by the late Sir George Grey, the carcase was fortunately acquired by the British Museum, where both its skin and skeleton are now preserved. The former specimen—a female purchased in 1851—survived till the summer of 1872, when its carcase was sold (apparently without the least idea of its priceless value) to a London taxidermist, from whom the mounted skin was acquired many years after by Mr. Walter Rothschild, for his museum at Tring. This specimen was apparently the last survivor of its kind, although, as already said, there was not even a suspicion that it belonged to a rare species. Most fortunately for natural history two or more photographs of this animal were taken in the summer of 1870 by Messrs. York and Son, and it is from these photographs (one of which is herewith reproduced) that most of the later figures of the animal appear to have been taken. They are probably the only photographs of a living specimen in existence.

According to a note published by the Secretary, in the *Proceedings* for 1891, the only other example of the quagga in the London Zoological Society's menagerie was one purchased in 1831. No record of its death appears to have been preserved, but it may have been the same specimen of which the skin was exhibited in the Society's old museum in 1838, or thereabouts. These, however, were by no means the only specimens brought alive to England, for as early as 1815 one was in the possession of Lord Morton, while somewhat later on in the last century Mr. Sheriff Parkins was in the habit of driving two quaggas in a phaeton about London, and in narrating this circumstance the late Colonel Hamilton Smith mentions that he himself had been drawn in a gig by one of these animals, which showed "as much temper and delicacy of mouth as any domestic horse." Another quagga was in the possession of a former Prince of Wales, and there are records of others in England. The skulls of the two driven by Mr. Parkins, as well as a portrait of one of them, are preserved in the museum of the Royal College of Surgeons.

In addition to the specimens in the British, Edinburgh, and Tring museums, several skins are preserved on the Continent. With one exception, all appear to be of the same general type as the London example photographed by Messrs. York in 1870. The exception is one in the Imperial Museum at Vienna, of which a description and photograph have recently been published by the Director, Dr. L. von Lorenz, in the *Proceedings* of the Zoological Society of London. Unfortunately there is no record as to the locality where the Vienna specimen (which is a female) was obtained, all that is known being that it was acquired by purchase in 1836.

Compared with the ordinary type of quagga, as exemplified by York's photograph, the Vienna animal is of somewhat larger dimensions, with a creamy buff (instead of greyish or chocolate-brown) ground-colour on the upper parts, with the exception of the head, which is clay-brown. A more striking difference is to be found in the broader dark stripes (of which there seem to be more in a given space), and a corresponding decrease in the width of the intervening light intervals. The stripes also seem to extend farther back on the body.

But there is also a difference between quaggas of the type of the one photographed by York and those figured by the early writers, as exemplified by the plate in Colonel Hamilton Smith's volume on horses in the *Naturalist's Library*. In the specimen there represented, which not improbably came from Cape Colony, and may be regarded as the typical form of the species, the head, neck, and fore-quarters are marked by narrow black stripes on a chestnut ground. The markings are, indeed, as Dr. von Lorenz remarks, just the reverse of those of the Vienna specimen; the British Museum example, and the one figured by York being in some degree intermediate between these two extreme types.

With some hesitation, Dr. von Lorenz suggests that there may have been local races of the quagga, as there are of Burchell's zebra Regarding Hamilton Smith's plate as representing the typical Cape quagga, the two other forms probably came from districts farther to the north, and the suggestion may be hazarded that the Vienna specimen, as the more aberrant, was obtained from the Orange River Colony or Griqualand West, forming the northern limits of the range of the species. For the race typified by the British Museum specimen the name *Equus quagga greyi* would be an appropriate designation, while for the one represented by the Vienna example the title *E. quagga lorenzi* may be suggested.

But it was not my intention when commencing this article to enter into a discussion of local races, but rather to point out what an interesting animal the quagga really was, and how great a loss its extermination has been to zoology.

Even in the days of its abundance the quagga (which, by the way, takes its name from its cry) had a comparatively limited distribution, ranging from the Cape Colony up the eastern side of Africa as far as the Vaal River, beyond which it appears to have been unknown. In this respect it closely resembled the white-tailed gnu, which, however, is known to have crossed that river in one district. Curiously enough the two species lived in close comradeship, and in the old days their vast herds formed a striking feature in the landscape of the open plains of the Orange River Colony. Both have now disappeared from the face of the country, for the white-tailed gnu, if, indeed, any are now left, only exists in a semi-domesticated state on a few farms.

Owing to its rank flavour, and especially its yellow fat, the flesh of the quagga was almost uneatable by Europeans, although it was keenly relished by the Hottentots, who, in the early days of the Cape Colony, were largely fed upon it by their Dutch masters. Whether this was the cause of its comparatively early disappearance from that part of the country, it is now impossible to say, but certain it is that when Sir Cornwallis Harris made his trip to the interior, in 1836, quaggas were no longer to be met with in any numbers in Cape Colony, although Colonel Hamilton Smith, writing a few years later, states that they were still to be found within its limits. North of the Vaal River they occurred, however, in their original multitudes, and it was not till about the middle of the last century that the Boers took to hide-hunting, and thus in a few years accomplished the extermination of the species.

Allusion has already been made to the facility with which the quagga could be broken to harness, and it seems probable that the species could have been more easily domesticated than any of its South African relatives. Another trait in its disposition is worth brief mention. It was said to be the boldest and fiercest of the whole equine tribe, attacking and driving off both the wild dog and the spotted hyæna. On this account the Boers are stated to have frequently kept a few tame quaggas on their farms, which were turned out at night to graze with the horses in order to protect them from the attacks of beasts of prey.

Throughout the whole of the plain country to the south of the Vaal River the quagga was the sole wild representative of the horse family, the true zebra being confined to

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the mountains of Cape Colony and adjacent districts. North of the Vaal River the veldt was, however, dotted over with herds of Burchell's zebra, the aforesaid bonte-quagga, which (inclusive) of its local races, has a very extensive geographical distribution in East and Central Africa. It is scarcely necessary to say that this species differed from the true quagga in having the whole body striped, as well as by its much more brilliant type of colouration and the pattern of the striping. One very remarkable feature in connection with this species must not be passed over without notice. In the original and typical race (now apparently extinct), which was obtained just north of the Vaal River, in British Bechuanaland, and therefore immediately adjacent to the northern limits of the quagga, the whole of the legs, as well as a considerable portion of the hind-quarters, were devoid of stripes. In this respect the typical form of the Transvaal species came much nearer to the last-mentioned animal than do the races from more northern districts, in which the hind-quarters and legs are more or less completely striped; the striping attaining its fullest development in the most northern race of all, the so-called Grant's zebra of Somaliland and Abyssinia.

Of course, these gradations towards the quagga-type of colouration of the more southern representatives of Burchell's zebra, as well as the difference in the colouration of the quagga itself as compared with zebras, have a meaning and a reason, if only they could be discovered. And it may be remarked incidentally in this place that unless we attempt to account rationally for such variations there is little justification for the modern practice of distinguishing between the local races of variable species.

The striping of the zebras, which there is considerable cause for regarding as the primitive type of colouration of the horse family in general, is evidently of a protective nature. It was stated some years ago that zebras a short distance off are absolutely invisible in bright moonlight, and I have reason to believe that the same is to a great extent the case in sunlight. For some reason or other the species inhabiting the plains (not the mountains, be it observed) of South Africa have tended to discard this striped colouration, the southern race of Burchell's zebra exhibiting the first, and the quagga the second stage in this transformation. In North Africa the transformation has been carried a stage further, the wild asses of the Red Sea littoral having discarded their stripes almost completely in favour of a uniform grey or tawny livery. In this part of the continent there is now no trace of a transitional form, whatever may have been the case in the past, and we thus have the sharp contrast between the uniformly coloured wild asses of the coast of the Red Sea on the one hand, and the fully striped zebras of Abyssinia and Southern Somaliland on the other.

Whether there is anything in the climatic and other physical conditions of the plains of Cape Colony which renders a partially striped species less conspicuous than one in which the striping is fully developed, the disappearance of the quagga makes it now impossible to determine. But observation might advantageously be directed to the comparative invisibility, or otherwise, of the wild asses of the Red Sea littoral and the fully striped zebras of the interior, and whether this would be affected in any degree by the transference of the one to the habitat of the other. Whatever be the explanation, the fact remains that at the opposite extremities of Africa some of the members of the equine tribe have developed a tendency to the replacement of a striped livery by one of a uniform and sober hue, and that in the south of the continent this tendency exists only in the species inhabiting the plains. Moreover, it is only in South Africa that the transitional form is met with, and only in the north of the continent that the striping has been completely lost.

But this is only one phase of a general tendency among mammals to replace their spots or stripes by a uniformly coloured coat, as is exemplified by the case of many deer, pigs, and tapirs, as well as by the lion and the puma among the Carnivora.

So far as I am aware, no one has ever attempted to give a philosophical reason for this remarkable tendency. But till an adequate explanation of the phenomenon be forthcoming, naturalists, to repeat the words of a well-known ornithologist, have left half their work (and I am inclined to think the more important half) undone. Without ascertaining the reason for phenomena of this nature our zoological work is, indeed, as though a man were content with describing the mechanism of a complicated machine without an inkling as to its use.

One word more, and I have done. To the systematic zoologist, the quagga is an animal of special interest as affording evidence of the intimate relationship between the zebras and the wild asses. Although, judging from its geographical distribution and its physical characteristics, it was probably not the actual transitional form between the striped and the uniformly coloured species, yet it serves to show the manner in which the transition was effected. In this sense it is undoubtedly a link, and since it is now, unhappily, missing from the roll of living animals, the reason for the title of the present article will be apparent.

ACROSS RUSSIAN LAPLAND IN SEARCH OF BIRDS.

By HARRY F. WITHERBY, F.Z.S., M.B.O.U.

IV.—IN THE BIRCH SCRUB AND ON THE ROCKY COAST.

THE concluding portion of my last article* found my companion and myself amongst the marshes near the northern end of the great Imandra Lake.

Our limited food supply continually drove us forward, so that however interesting a place might be we could never afford to stay there long. Rowing to the head of the Imandra, we landed at the mouth of a small river which flowed into the lake. The river was full of rapids, and could not be ascended by a boat, so we walked across country to a little lake, which the river connected with the Imandra.

Crossing this lake—the Pereyaver—we arrived at an interesting water parting. An almost level strip of land of only some five hundred yards across separated two chains of lakes and rivers—the one up which we had travelled flowed southward and reached the White Sea, while the other rushed northward and found an outlet in the Arctic Ocean.

At this sp t we were attacked by vast swarms of blood-sucking flies, so small that they easily passed through the mosquitoe veils, and so voracious and poisonous that we were soon suffering from swollen glands and intense ear-ache. We were forced to pack up and flee northwards, camping eventually on the shores of the Pulozero. Here we found unexpected civilization in the shape of a well-built telegraph station, inhabited by a most hospitable official, who treated us with every kindness. Although somewhat short of flour himself, he provided us with bread, which we sorely needed, and in the way of luxuries he had his bath house heated and prepared for our use.

* *See* KNOWLEDGE, June, 1902.

This gentleman was very anxious that I should take his portrait, and notwithstanding my protestations that the picture probably would be unsuccessful, and at all events small, he insisted upon dressing up in his full uniform which included a sword and a medal. One of the telegraph line inspectors was proclaimed to be a great sportsman, and was anxious to take us to some marshes at some distance, which he reported to be the haunt of wild geese and swans. We gladly accepted his services as guide, and taking a few men and our tent we set off for the marshes. The walk thither was most trying, as it was pouring with rain, and we had to wade for miles uphill through slush and soft moss. The marshes, however, were extensive, and were the breeding haunts of a number of interesting

Fig. 6.—The Telegraph Sportsman and Gregori (interpreter) at Pulozero.

wading birds, amongst others being the dusky redshank, and the bar-tailed godwit, which were mentioned in my last article. But we never saw a sign of a goose or a swan, and our guide's sporting achievements were none too brilliant. He stayed for a long time at the edge of a small lake, and fired many rounds at a flock of ducks fully two hundred yards away. Soon afterwards I saw him fire twice at something on the ground, and on reaching him I saw that his mark was a fluffy little greenshank. On catching the chick we found one of its toes slightly injured by the shot.

As we journeyed northwards from Pulozero the character of the country gradually changed. The pine forest became thinner, and the birch trees more numerous until the pine trees eventually disappeared. Then the birch trees in their turn become scarcer and stunted, and the dwarf birch and many other kinds of creeping plants began to get the upper hand, until at the coast the only trees were a few wind-blown birches, while even the creeping plants in many places were unable to exist, and reindeer moss, hoary and luxuriant, reigned in their stead.

The change in the vegetation had a marked effect upon the bird life. For instance the capercaillie disappeared with the pine forest, and willow grouse* increased in numbers as the country became more open. The plumage of the willow grouse especially interested us. This bird is familiar to all in its winter garb of white when it appears in the poulterers' shops under the name of ptarmigan. In summer, however, its plumage is brown, much like that of the red grouse, except that its wing feathers always remain white. In high northern altitudes where spring, summer, and autumn are crowded into a few months, the bird often retains part of its white plumage, especially on the breast, throughout the summer; so that we were not surprised to find all the willow grouse bearing old winter feathers in August. But when we came to examine these birds we discovered that they were still in the midst of the "spring" moult, their breasts and backs being covered with new and growing feathers, many of them only just peeping through the skin. It seemed doubtful that these birds would complete this moult that year before the winter plumage became necessary, for already new snow was falling on the hills, the mosquitoes were fast dying, and autumn had commenced. The exceptionally late summer accounted, no doubt, for this curious state of plumage, and as we journeyed north other anomalies caused by the backward season were apparent.

Most of the willow grouse had broods of very small chicks, and, like other gallinaceous birds, the parents were active in using various devices to attract the intruder's attention while their young ones were rapidly getting under safe cover. To give a few instances. I was watching a hen bird feeding her chicks which were jumping up to her beak and pecking bits of food from it. Suddenly she saw me, and uttering a harsh and low chuck she began to run like a rat through the grass and undergrowth, but keeping always in full view. Meanwhile her chicks had scattered in every direction and had disappeared like magic. One old hen which I came upon very suddenly, rushed up to me cocking her tail and holding her head as bravely as a bantam, she was so defiant, and came so close, that I thought she was going to strike me. The cock birds were as eager to protect their young as the females. Once, on surprising two old birds together with their brood, the hen immediately made off, but the cock flew straight at me and fell over, as though shot, almost at my feet. He quickly picked himself up, and, crouching low, crept away dragging his drooping wings along the ground.

At Kitsa, where two log huts formed a "station," the food question became acute. We had run matters rather fine in our desire to stay as long as possible in the country, and now we had but a tin of tongue left for ourselves and nothing for our men. However, fortune favoured us, for at the foaming junction of two rapid rivers we caught a fine salmon, and higher up one of the rivers a good trout and a pike. They were soon cooked, and our men ceased grumbling, while we were glad to have a substitute for tinned food. Nevertheless, we hurried forward to Kola, a small village of wooden houses, and the capital of Russian Lapland.

Historically Kola is famed for having been bombarded (inoffensive and unprotected fishing village as it is) by a British gunboat during the Crimean war. It is prettily situated at the base of a hill, flanked on both sides by rivers flowing into a fjord, which takes its name from the village. Here we were once again in communication with the outside world. We paid off our men, who set off back to their homes by the way we had come. They had no loads, but their pockets were heavy, their pay being in silver, and their hearts were glad, while as to their heads I am afraid they were lighter even than usual, for until Kola was reached the men had long abstained from vodka.

We found plenty to interest us during the two days which we spent in Kola while waiting for a steamer to take us down the fjord. Most of the inhabitants were

Lagopus albus.

away fishing on the Murman coast, but the people who were left were very nice, and a great contrast to the peasants of Kandalax. They seemed to be happily influenced by their proximity with Norway. A little boy to whom I gave a copek for bringing me a telegram, took of his hat and shook my hand in true Norwegian fashion.

I should not dare to boast of my own culinary efforts, but my companion had for a month proved himself an excellent *chef*. Nevertheless, it must be acknowledged that on boarding the steamer which was to take us to the coast, we took a very great interest in the wonderful dishes put before us (and not in vain) at the first few meals.

We had determined to work in the neighbourhood of the coast for a week, so we disembarked at Ekaterina—a remarkable place at the mouth of the Kola Fjord. The harbour of Ekaterina is practically land locked, and thus well protected from all winds. Moreover, by the kindly influence exerted by the Gulf Stream it is the most easterly harbour in the north of Europe which is free from ice at all seasons, and is thus the only northern port possessed by Russia which remains unfrozen in the winter. Though the water is deep the harbour is small, being only about a quarter of a mile wide. It would not, therefore, be convenient for large war vessels which could not easily turn in it. Nevertheless, the Russian Government have here built a small dry dock, and at great cost have constructed a fine road up the rocky slope which descends abruptly to the water's edge. The road leads to the only level piece of ground on the hills round the harbour. This was a small marsh, but has now been drained, and some fifty wooden buildings forming the new town of Ekaterina have been erected upon it. These buildings were all made in Archangel, and brought thence in parts. They include a fine church, a custom house, a school, and other public offices. During our journey through Lapland, Ekaterina had just been completed, and had been opened officially with great ceremony.

We spent a most enjoyable week here, being most hospitably entertained by a party of Russian marine biologists, who were installed in a well-fitted laboratory. Although the weather was wretched we much enjoyed the bracing air of the coast after the muggy atmosphere of the interior. We were able to add considerably to our collection. The most remarkable point about the birds on this rocky northern coast was the fact that many of them still had nests with fresh eggs, although the winter was coming on apace. Mealy redpolls* were common amongst the stunted birch trees, which struggled for an existence in the dells amongst the rocks, where they were more or less protected from the winds. Most of the redpolls had fresh eggs in their beautiful little nests, and I feel sure that these were first broods, for I saw no young birds about. One nest contained a dead bird sitting on two eggs. On dissecting this bird it was evident that it had died "egg-bound," which I fancy must be a rare occurrence amongst wild birds.

One day we saw a diver flying over a hill. As we watched, it began to circle, and eventually flew down behind the hill. We crept over the slope, and found a small tarn on the other side, and seeing no bird about we concluded that it had gone on to its nest. So we separated and walked carefully round the small lake. I had not gone far before a large bird slid silently off the bank into the water. Swimming rapidly for a short distance, it suddenly raised its body perpendicularly in the water, and flapping its wings began to croak loudly. As I wanted the bird I did not delay long in shooting it, knowing well from experience that when once these birds begin diving it is next to impossible to get them. The bird proved to be a red-throated diver.* On the bank from which it had slid were two fresh eggs, placed in a depression in the wet moss within a foot of the edge of the tarn. From the nest to the water was a shallow trough worn in the moss by the bird which was accustomed to slide from its eggs down into the water. My friend and I waited patiently

Fig. 7.—Red-throated Diver on Nest.

in turns for many hours well hidden near the nest, hoping that the other bird would come to the nest. But it never appeared, although its mate which we had shot proved to be the male. The photograph here reproduced is one of the dead bird on the nest, and was taken in the pouring rain.

Bidding adieu to our kind Russian hosts we sailed for Vardoe. Here we had to wait six hours for a steamer to take us south, and during that time we employed ourselves most profitably in collecting birds. We found a number of interesting species congregated in a field attached to a small fort. On one side some soldiers were drilling, on the other a sentry was pacing up and down. Still we were determined to have those birds, and accordingly climbed over the fence and proceeded to get them. In our eagerness we had soon forgotten the sentry, and were surprised after shooting some six or eight birds to see him buckling on his sword and running towards us. Pocketing the birds, as well as the little poaching gun which we had been using, and climbing out of the field, we went to meet the little man in the most innocent way. However, he received us with an awful torrent of what sounded like abuse. We were both most ignorant of the Norwegian language, and the only expression I could think of as at all benefiting the occasion was a word sounding like "umflelardles," and signifying "I beg your pardon." Accordingly I repeated this word many times in the suavest possible way, and then we walked rapidly away to our boat, leaving the soldier in a most indignant rage. Unluckily some boys had seen and heard the whole of the fun, and they followed us through the town shouting out the tale, and repeating some of the sentry's choicest expressions, as well as my apology, which seemed to cause the inhabitants great amusement. We were well able to join in the laugh, because our hare pockets bulged conspicuously with a rich booty.

. . . . . .

* *Linota linaria.*

* *Colymbus septentrionalis.*

How tame and artificial seemed the pleasures and luxuries of civilization soon after our return home. How we sighed for the wild freedom of camp life. Little hardships, and even the tormenting mosquitoes of Lapland, were forgotten in a feverish longing to roam once more over some country untouched by man—the desire to be alone with Nature in her wildest aspects was our strongest passion.

NEBULOUS STARS AND THEIR SPECTRA.

By Miss Agnes M. Clerke.

With his great photographic binocular, Dr. Max Wolf secured, in July, 1901, two simultaneous impressions of the extraordinary object named by him the "America" nebula. One, lately reproduced in these pages, has excited the wonder and admiration of all competent judges; the second has not yet been published. The comparison of the twin pictures would be of extreme interest. To take just one example. Even a cursory examination of the July plate shows the nebulous light to be interrupted, often where it is brightest, by isolated spots of absolute blackness, round or oval, and sharply terminated. Their identification in the companion-photograph would leave no doubt of their objective reality. The peculiarity is the more noteworthy from its extensive sidereal prevalence. Stellar and nebular formations are alike liable to perforation; whether as an incident in their development, or through the action of external forces, we cannot pretend to determine. The pits and chasms in the Trifid Nebula strike the eye at once in the beautiful pictures obtained by the late Prof. Keeler with the Crossley reflector. Dark areas and "black, tortuous rifts," assert their presence emphatically on Dr. Roberts's plates of the nebulous cluster in Monoceros,* (N.G.C. 2237-9). The "Key-hole" Nebula manifests the same characteristics on an enlarged scale; while the Milky Way itself bears witness to its dominance over the distribution of cosmical masses to the utmost bounds of the visible universe. Moreover, globular clusters are apt to be riddled with "holes." Prof. Barnard's recent study of M. 5 Serpentis, with the forty-inch Yerkes refractor, brought to his surprised cognisance a number of "inky black spots," close south-preceding and south-following, the densest part of that singular aggregation.† He had, indeed, been previously aware of the presence in M. 13—the great Hercules cluster — of similar disaggregative symptoms (if as such we are justified in interpreting them). Nor are they absent from nebulous stars. The luminous halos surrounding these rare objects are not, as a rule, symmetrically disposed. They are frequently irregular and heterogeneous, and show vacancies and mottlings altogether inconsistent with the supposition of their condition being one of statical equilibrium.

Nebulous stars probably represent the earliest phase of stellar evolution. They irresistibly suggest incipience; they have seemingly not yet fully appropriated the material allotted for their construction. In the course of a few or of many millenniums, they will, it is reasonable to suppose, have absorbed the outstanding supply and will shine as finished suns. Hence, particular importance attaches to the investigation of spectra emanating, presumably, from inchoate photospheres. For the ascertainment of their nature serves to determine, with approximate security, the starting-point of the grand process by which suns grow and decay. And, judging from the scanty information so far available, this starting-point is from stars marked by helium-absorption. By helium-absorption, associated—as Mr. McClean and Miss Maury independently concluded—with light-stoppage by all the three series of hydrogen, by oxygen, perhaps invariably, and very frequently by nitrogen and silicon. The action of metals is, in these early spectra, quite inconspicuous, and metallic rays form no part of the emissions of gaseous nebulæ, so that the prominence of metalloids in stars of itself suggests their proximity to a nebulous condition.

Now the spectra of stars with nebulous appurtenances are mainly impressed with dark lines of helium, hydrogen, and oxygen. It is too soon to pronounce the rule an invariable one; but until some one exception to it has been established, it may be admitted as a provisional generalisation. At the first sight of Dr. Max Wolf's photograph (already adverted to) of the "America" nebula, such an exception seemed to present itself; for the strongly nebulous star close to its western border was named in the text ξ Cygni, and ξ Cygni shows a spectrum of the solar type. Further enquiry, however, proved that there had been an accidental error of identification, and that the star in question is no other than 57 Cygni, the spectrum of which has the letter "B" affixed to it in the Draper Catalogue.* This means that it shines with the "Orion" quality of light; and on turning to the supplementary remarks, we note the record of a distinctive line of cosmic hydrogen, in addition to those of helium and of vacuum-tube hydrogen. The real ξ Cygni lies on the *Pacific* side of the nebulous continent—looking at it as if it were depicted on a terrestrial map—and in about the latitude of San Francisco. But in the ocean of space it is probably situated indefinitely nearer to us than the nebula projected beside it upon the sensitive plate. It may, in actual fact, be just as completely disconnected from it as a reticle from the celestial bodies it serves to divide and define.

This cannot be said of the diffuse object off the *Atlantic* shore of the nebula. Prof. Wolf states that, in the original negative, "many interesting arms and wings of nebulosity" can be perceived to radiate from it. And, although he does not assert categorically their organic relationship with it, the chance of the fortuitous production of an arrangement so express and particular must be regarded as extremely remote. It is, indeed, admittedly difficult to discriminate, in long-exposure photographs, between stars genuinely and stars only optically nebulous, yet the visible origination of nebulous appendages can scarcely be fictitious. Thus, the situation of 57 Cygni, with regard to the filmy protrusions apparently issuing from it, is too critical to be casual; and, as we have seen, the spectrum of the star corresponds perfectly with a nebulous condition.

Its brightness—4·6 magnitude—is almost that of ω Orionis, detected as nebulous, both photographically and visually, by Barnard in September, 1893 (Knowledge, Vol. XVII., p. 17). The two stars are also spectroscopically alike; they constitute similar foci of nebulous concentration; each would seem to be a diffuse globe but recently equipped with the machinery requisite for intense radiation. With them may be classed σ Scorpii, one of the finest nebulous stars in the heavens, described by Barnard as structurally involved in the great Rho Ophiuchi formation; ε and ι Orionis, the "atmospheres" of which were noted by Sir John Herschel; and λ Orionis, disclosed as haze-encompassed by a long fixed stare with Barnard's Willard lens. This object is one of Struve's pairs (Σ 738); the

* "Celestial Photographs," Vol. II., p. 171.
† *Astr. Nach.*, No. 3519.

* Dr. Max Wolf desires to acknowledge Miss Clerke's correction, and would ask readers of Knowledge, in his article on page 156 of Knowledge for July, 1902, at the 20th line, *for* "ξ Cygni," *to read* "57 Cygni."

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components, of respectively fourth and sixth magnitudes, are 4″·2 apart, and display—or, at least, displayed to early observers*—contrasted tints of yellowish and purple. The pure radiance, nevertheless, of a Golconda diamond would match better their joint spectrum. It is of a highly primitive pattern; the lines crossing it are few and diffuse; and they claim, all but exclusively, a metalloidal origin. Those of helium, together with the Huggins and Pickering series of hydrogen, are unmistakable,† and absorption by oxygen and nitrogen will assuredly be found when carefully looked for.

One apparent anomaly remains to be mentioned. A 5·5 magnitude star in Scutum Sobieski (B.D. 10° 4313) came out on one of Barnard's plates in 1892, surrounded by an extensive tenuous halo.‡ Yet in the Draper Catalogue, where it is enrolled as No. 8198, a spectrum of the Capellan variety is assigned to it. Assigned, indeed, with some hesitation; still we cannot but note the confirmatory circumstance that the star is fainter chemically than optically, while in helium-stars an opposite disparity is always observed. A single good spectrograph would settle the point. Nor should the genuine nebulosity of the object be admitted on the unsupported evidence of an isolated negative. Verification should be sought by repeated and varied exposures, for the question whether a solar star can be nebulously involved is really fundamental to theories of relative stellar ages.

It might have been anticipated that nebulous stars would be found to shine predominantly by emission—that bright lines would be conspicuous in their spectra. Facts, however, do not bear out this forecast. An immense majority of bright-line stars are entirely free from nebulous entanglements. The conditions are combined, and that imperfectly, only in the stars of the Orion trapezium, which give feeble signs of spectral emission; and in two members of the Pleiades group, Alcyone and Pleione, neither of which is in such immediate connection with nebulous structures as some of their dark-line associates. Nor is there at present any reason to suppose that the nuclear stars which, in planetary and annular nebulæ, appear the very foci of constructive activity, emit gaseous radiations. Those that do—and they are very few—are palpably not stars, but condensed wisps of cosmic haze. Experience does not then warrant the current surmise that the first stage of stellar development is marked by a bright line spectrum. The requirements for its production would rather seem to be independent of age, and to arise under special influences, or through exceptional peculiarities of constitution. But the topic, being one of the most arduous in astrophysics, is emphatically one upon which dogmatic pronouncements would be out of place.

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

XVIII.—VARIOUS SKY EFFECTS.

There are certain phenomena which lie very near the border line of astronomy and meteorology; so near that it is difficult to say which science has the stronger claim to take note of them. Amongst these, perhaps, those which have the best claim to be included in the department of astronomy are the strange bright clouds which were discovered by Ceraski, and which were afterwards made the object of careful study by O. Jesse. These Luminous Night Clouds were utterly unlike any phenomenon which had been previously recorded, and their discovery, like that of the Gegenschein, was a striking evidence that not even yet have the fields of work which lie close at hand been all explored. There is still an ample harvest to be reaped in more than one direction by the man who can reinforce an observant eye by thoughtful patience.

These luminous clouds were not visible at every time of the year, but only during the nights of summer; their period of visibility for Berlin, where Herr Jesse observed them, being from May 23rd to August 11th; a period corresponding nearly to the season of continual twilight for that latitude. Their light was derived from the sun, which during that season is never more than 18° below the northern horizon, and the rays of which they were enabled to catch by their great height above the surface of the earth; for the comparison of photographs taken of them from different stations showed that they ranged from fifty to fifty-four miles in elevation, or ten times the height attained by light cirrus clouds.

In appearance these night-clouds were of a brilliant silvery-whiteness, slightly tinted at times with blue if near the zenith, or with a reddish-yellow tinge if near the horizon. They were woolly and striated in character, and repaid examination with a field-glass of large aperture, by means of which they might be traced considerably further than the naked eye could follow them.

The discovery of an order of clouds at a height above the earth so greatly exceeding anything which had ever been observed, even of the lightest cirrus, was remarkable enough. More remarkable still were their variations. For they were not by any means a permanent phenomenon, and diminished in frequency of appearance from the time of their first discovery. From 1885 to 1889, they were seen before midnight; later they could only be detected in the morning hours. Their movements were more interesting still, and were such as might be caused—so it has been suggested—if, though travelling with the earth, they were but lightly subject to its attraction, and experienced some retardation as they travelled with it.

From any point of view the existence of these clouds must be regarded as most remarkable. That clouds should exist at all at a height greater than the highest stratum to which we owe twilight, and that so existing they should be an occasional and variable phenomenon are entirely unexpected discoveries, and still remain unexplained. Can it be that they are one of the by-products of the great volcanic eruption of Krakatoa in 1883? If so, they may be looked for after any great series of volcanic outbursts, such as that which commenced with the destruction of St. Pierre in Martinique in May, 1902, even though these eruptions cannot compare in violence with that of Krakatoa.

Three striking sky-effects followed that great eruption of 1883. The first was comparatively restricted both as to area and time, and took the form of a remarkable colouration of both sun and moon. At Batavia, in Ceylon, at various places in India, the sun was seen to be blue or green; blue when at the zenith, changing through green and yellow to total obscuration near the horizon. A much more lasting effect was that which received the name of "Bishop's Ring," having been first reported from Honolulu by the Rev. S. E. Bishop on September 5th, 1883. This ring was a remarkable species of halo to be seen on every fine day surrounding the sun from its rise to its setting, and even occasionally round the moon. Thus in the Stonyhurst Observatory report for 1883, it is stated: "During the day the sun is invariably surrounded by an intense silvery brightness slightly tinged with green, and at a distance of about 20° from the sun this tint sometimes changes gradually into a pink or pale violet, and fades

* Webb, "Celestial Objects," Vol. II., p. 182, Espin's ed.

† A. C. Maury, "Harvard Annals," Vol. XXVIII., p. 111.

‡ *Astr. Nach.*, No. 3111.

away at about 45° . . . . an orange tinted haze extending about 45° from the moon was also seen on several nights towards the middle of December." There can be no doubt that "Bishop's Ring" was a diffraction effect due to an immense quantity of dust particles of an extreme minuteness driven up by the great explosion to a great height in our atmosphere and slowly subsiding. For as late as 1887 the ring still remained, though it could then be only traced as a peculiar white haze to a distance of about 10° from the sun.

The third result of the eruption of Krakatoa was the occurrence of "Afterglows" at sunset and "Foreglows" at sunrise. These were distinguished from normal sunsets and sunrises in that they differed from them in the time of their appearance and the place or quarter in which they were formed; in their periodic action or behaviour; in the nature of the glow, which was both intense and yet lustreless; in the regularity of their colouring; in the colours themselves, which were impure and not of the spectrum; and, lastly, in the texture of the coloured surfaces, which were neither distinct cloud of recognised make nor yet translucent mediums. The regularity of their colouring was particularly striking. "Four colours in particular have been noticeable in these afterglows, and in a fixed order of time and place—orange, lowest and nearest the sundown; above this, and broader, green; above this, broader still, a variable red, ending in being crimson; above this, a faint lilac. The lilac disappears; the green deepens, spreads, and encroaches on the orange; and the red deepens, spreads, and encroaches on the green, till at last one red, varying downwards from crimson to scarlet, or orange, fills the west and south."*

These magnificent afterglows reappeared, but on a diminished scale, after the Martinique eruption of May, 1902. A valuable letter by Prof. A. S. Herschel appeared in *Nature* for July 24th, 1902, describing the afterglow of June 26th. The sun set about 8h. 25m., and a quarter of an hour later a long low belt of sky in the N.W. had grown orange-yellow, whilst the ruddiness of the sky in the east had by the same time risen nearly to the zenith. Between the two there lay a white tract about 30° in width, which was gradually invaded and at last quite occupied by the advancing ruddy colour from the east. About 8h. 55m. from the zenith down to 30° above the place of sunset, and for 40° or 50° on either side of the vertical line through it, was a broad expanse of rich, rose-coloured, lake-red light. This red glow sank rather rapidly in height, and by 9 p.m. it had subsided into a brighter glow near the horizon.

The colour effects of an ordinary sunset are due to the depth of atmosphere through which the sunlight reflected to us from the clouds has passed before illuminating them. In their passage the rays of short wave-length suffer a greater scattering, and are therefore lost to us in a greater proportion than those of greater wave-length, with the effect of producing a golden or ruddy glow. The afterglow would appear to be due to the intervention of a reflective stratum at a greater height than that of ordinary clouds. In 1883 this was no doubt composed of the finely-divided volcanic dust to which "Bishop's Ring" had been due, suspended high in our atmosphere, and no doubt the afterglows of 1902 owed their origin to a similar cause. The height of that stratum can be inferred from the depression of the sun below the horizon at the time when the further boundary of the glow is setting, or is at some definite altitude, or from the elevation of the zones of its greatest brightness. In this way Prof. Herschel found the elevation of the reflective stratum on June 26th as about five miles; whilst on June 28th, he estimated "the sun's parting illumination of the sky to rosy colour" at not much more than 30 minutes after sunset, and the height of the dust stratum in consequence as about 7½ miles.

These intervals were very distinctly shorter than those remarked in 1883 and 1884. The primary glow after Krakatoa averaged 54 minutes after sunset until its disappearance on the horizon; the secondary averaged 96 minutes. If the secondary glow be due to direct sunlight, the average height of the stratum causing it must have been nearly 40 miles. But if, as appears more probable, the secondary glow was due to the same stratum as that which produced the primary, being in fact a second reflection from it, then the mean value of its height would be about 11 miles.

On a bright clear evening, as the sun goes down, an interesting phenomenon may often be watched. If the observer turns his back on the sun, he will see in the east, immediately after sunset, a long dark line spread along the horizon. This darkness, which is indeed "the Shadow of the Earth," thrown upwards as the sun goes down, rises somewhat rapidly, its upper edge, under favourable circumstances, being quite sharply defined. This "shadow of the earth," which may be made out more or less distinctly on any clear evening in a suitable locality, and which is especially easy to watch at sea, revealed itself in a very interesting manner in the case of the luminous night clouds described in the beginning of this chapter. If the clouds were seen in the earlier portion of the night, that is to say before midnight, then the shadow of the earth covering them little by little would darken them from the top downwards. On the other hand, if they were first seen after midnight, then it was the upper edge that lighted up first, the cloud rising out of the shadow.

The "Earth's Shadow" came strongly into evidence in the case of the Krakatoa "afterglows." The Rev. S. E. Bishop, writing to *Nature*, Vol. XXIX., p. 549, says:—

> "I beg special attention to my former remark of the 'earth-shadow sharply cutting off' the upper rim of the first glow. This was very manifest in the strong heavy glows of September, showing clearly that the first glow directly reflected the sun's rays, while in the afterglow, which had no defined upper rim but continued much longer, the haze reflects only the light of the first glow."

And, again, in *Nature*, Vol. XXX., p. 194, he writes:—

> "In your issue of April 10th (p. 549), is the statement by an observer in Australia that the 'red glow was margined by an immense black bow stretching across from the north-west to south-east.'
>
> "I wish to say that the above language almost exactly describes the appearance to which I alluded on the same page as 'the earth-shadow cutting off the upper rim of the glow.' The 'black bow' of the Australian was evidently the shadow of the horizon projected on the haze stratum. In both the above cases the lower surface of the haze was evidently well defined, so that, as the horizon intercepted the direct rays of the sun, a well-marked shadow moved westward and downward. Above this black rim or bow appeared the secondary glow, produced by the reflection of the sun's rays from that portion of the haze surface which was directly illuminated. Very often the second glow was more conspicuous and impressive than the first, because it shone against the dark sky of night."

If the secondary glow were due to the reflection of direct sunlight, then no doubt its upper edge would have been sharply marked off by the earth's shadow, just as was the case with the primary glow. But its diffusion as compared with the definiteness of the earlier glow points to its being a reflection of the latter, a view strengthened by the fact that the depression of the sun below the horizon at the sinking of the second glow was as nearly as could be determined double what it was at the sinking of the first.

Prof. A. Riccò, in addition to these two points, mentions a third. From time to time in fine weather the phenomenon is presented at sunset of "Crepuscular Rays." These are broad pink ribands of light diverging like the

* Gerard Hopkins: *Nature*, January 3rd, 1884, p. 223.

XUM

sticks of a fan from the point where the sun has just gone down. They are formed in a very similar manner to the rays of light which we sometimes see in moisture-laden air, when the sun itself is hidden behind a dense cloud, and which children are accustomed to speak of as "the sun drinking." In the latter case, these bands of light are due to the sun shining out from between irregularities of the clouds and lighting up the laden air, which shines in the path of the rays just as the particles of dust do—"the motes in a sunbeam"—when light is admitted through a small aperture into a darkened room. In the case of the crepuscular rays, mountain ridges or banks of cloud may serve to partially intercept from the upper atmosphere the light of the sun which has set, throwing their shadows in long lines upwards, whilst the sunset glow shines out in the intervals between the clouds or in the depressions between the mountain peaks, and is seen by us as a radiating system of broad pink streamers. Here in England it is rare that these streamers can be traced very far towards the zenith; they are usually lost as they pass overhead, though sometimes their termination may be seen as counter rays in the east. Col. E. E. Markwick,* however, records that he has seen the rays in South Africa night after night extending from horizon to horizon; the radiation from the west and convergence again towards the east being, of course, an effect of perspective. In the case of the Krakatoa sunsets, Prof. Riccò remarked on several occasions these crepuscular rays as being conspicuous in the primary glow, but they were not seen in the secondary, a further proof that the former was due to direct, and the latter to reflected sunlight.

If we look across water towards the setting sun, we see a broad track of light extending from below the sun's place towards us, due to the reflection of the sun from the surface of the waves. It occasionally happens that an analogous reflection is produced in the air from the under surface of ice-films floating horizontally. In this case a vertical shaft of light is produced, rising from the sun as a base, which is known as a "Sun-Pillar," and of which a very fine example was seen on March 6th, 1902, over the greater part of southern England. The difference between the formation of such a sun-pillar and the Krakatoa afterglows depends partly upon the greater elevation of the stratum giving rise to the glows, and partly because of the smaller size of the particles forming it. The ordinary atmospheric particles are very small compared with the wave-length of light, and hence scatter especially the shorter rays, those producing the sensation of blue. The particles of the Krakatoa dust were large in comparison with these, and hence scattered rather the rays of long wave-length—the red rays. The composite effect of the glows therefore resulted from the interaction of these two different orders of particles upon the rays passing through them. And over and above the richer and more complicated sunset colours that were thus produced, there was the reflection of the sunset glow itself by a stratum of highly reflective dust particles at a great elevation.

"Thus we may probably conclude that the haze which followed the eruption of Krakatoa, and produced the twilight glows, was composed mainly of very fine dust, and that this dust at a great altitude reflected the light of the setting or rising sun after diffraction through the stratum and diffraction and absorption by the lower atmosphere, and secondarily again reflected this reflected light."†

The heavens are the province of the astronomer, the atmosphere of the meteorologist, and all the various phenomena that have been referred to above belong to the atmosphere, and hence meteorology may be said to have a claim upon them. But they are distinguished from purely meteorological objects—such as the various orders of clouds, rainbows, haloes, parhelia and the like—in that they are connected directly with the earth's rotation, and with its position relatively to the sun. They are phenomena of the earth as a planet rather than of the earth considered as a world complete in itself, and from this point of view may be considered as belonging to astronomy. But they are referred to here, not so much on this account as from the illustration they afford of the value of the habit of exact observation. "Science," it has been often said, "is measurement"; it certainly depends upon the record of phenomena in numerical form. The difference in value is immense between the most vivid and picturesque description of a flight of a meteor and the half-dozen numbers which give the time of its appearance, its brightness, and duration, and the precise position of its path. It is only the latter which are of permanent value, and it is only from the habit of registering the obvious facts connected with a given phenomenon that the faculty is developed of recognizing other points needing numerical expression and record. Thus in the case of the beautiful sun-pillar of March 6th, 1902, though many vivid descriptions were written of it, so far as I know only one observer noted what should have been apparent to all, namely that the pillar moved an appreciable distance in azimuth, following the unseen sun in its northward movement below the horizon. So in the case of the afterglows it was only those observers who had made specific observations of ordinary sunsets, and who knew accurately their characteristic features, who could state definitely and with precision that the sunsets after Krakatoa were abnormal, and define wherein their peculiarities consisted. Striking as they were, it was by no means everyone who saw anything in them out of the common, and even so experienced an artist as the late Mr. John Brett, F.R.A.S., failed to recognise wherein they differed from an ordinary sunset, or indeed that they differed from it at all. Then when their abnormal character was recognised, the careful timing of the sinking below the horizon of the primary and secondary glows was of the first importance as giving the means for computing the height of the reflecting stratum. In the case of the appearance of such glows on future occasions, or of the crepuscular rays, or of a sun-pillar, it is very desirable that not only a precise note of the times of the phenomenon should be taken, but that also the angular extent of the various rays should not be merely roughly estimated but actually measured. A long, light, but stiff rod carrying a sliding cross-piece—a sort of tangent staff, in fact, not unlike that used by Chandresakhara—would be of much service in determining the height and breadth of a sun-pillar, the angle which a crepuscular beam made with the horizon, the height of the brightest part of an afterglow, and so on. Such an instrument might, indeed, seem rough, but its accuracy and precision would be found to be beyond comparison greater than that of mere estimation.

* KNOWLEDGE, 1901, April, p. 88.

† Hon. Rollo Russell: "The Eruption of Krakatoa," p. 195.

THE ECLIPSE OF THE MOON, OCTOBER 17 AND HOW TO PROJECT IT.

By W. SHACKLETON, F.R.A.S.

FROM few problems in astronomy can such satisfaction be derived as that of the projection of a lunar eclipse. Moreover, it is so simple that few need fear to attempt it, and thereby be able to delineate the phase of an eclipse at any moment, whilst it is instructive in that actual use is made of terms which are frequently no more than definitions.

Just before sunrise on the morning of the 17th the moon is totally eclipsed, and although the following method is applicable to any lunar eclipse, we will deal more particularly with the one of this date. An eclipse of the moon takes place when the moon plunges into the earth's shadow, and thus is deprived of the sun's rays. If then we can ascertain the size of the shadow at the point where the moon is situated, and also know the direction and rate of movement of the moon through it, we have the material for predicting any particular phase of the eclipse.

From the *Nautical Almanac* we have given—

Moon's equatorial horizontal parallax	= 59′ 13″	= 3553″
Sun's " " "	= 9″	= 9″
Sun's radius	= 16′ 3″	= 963″

Adding the two former, and from the sum subtracting the latter, we get 2599″, which represents the radius of the earth's shadow at the point of the moon's orbit.*

The earth's atmosphere, however, tends to increase the size of the shadow, and on this account it is usual to increase the above radius by about $\frac{1}{50}$th; we will therefore take—

Radius of shadow = 2650″.

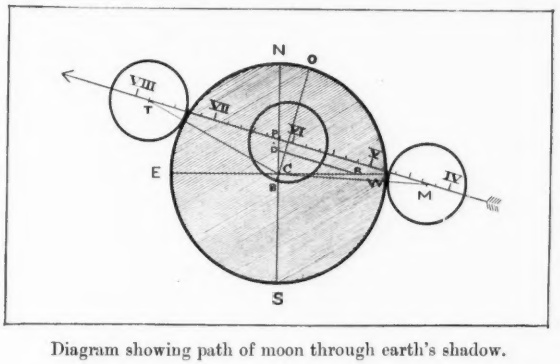


Diagram showing path of moon through earth's shadow.

Take a convenient scale of equal parts (say $\frac{1}{100}$ inch = 10″), and with C as centre and radius C W equal to 2·65 in., describe the circle N E S W representing the earth's shadow.

The declination of the centre of the shadow C will be the same as that of the sun but of contrary sign, thus since the declination of the sun is south, that of the

Shadow = N 8° 55′ 21″,

whilst the Moon's declination = N 9° 8′ 53″

make C P = 13′ 32″ = 812″,

which is the amount the moon is north of the centre of the shadow; also make

C D = 9′ 11″ = 551″,

which is the hourly motion of the moon from the shadow in declination, and since the direction of this motion is northwards, the point D is taken north of the centre C; also make C R equal to the hourly motion of the moon from the sun in right ascension, this is 32′ 14″·7, which, to be represented on the line C W must be reduced to the arc of a small circle by multiplying by the cosine of the declination, thus:— 32′ 14″·7 × cos. 9° 9′

= 1934·7 × 0·9875

∴ C R = 1910″.

Join R D; then by the parallelogram of velocities this represents the direction and hourly rate of the moon's motion.

Through P draw M T parallel to R D; it is evident then that M T represents the path of the moon through the shadow. P is the position of the moon's centre at the time of opposition = 6h. 10m. 13·1s., and since R D represents the motion in one hour, a proportional part, P VI., can be taken equal to the motion in 10m. 13·1s., then VI. will be the position of the moon at six o'clock. Make the distance from VI. to V., and from VI. to VII., &c., equal to R D, and we have a time scale which may be sub-divided, and from which the time of any phase may be derived.

The moon may now be drawn in at any required position, such as the first contact at M, by taking the radius of the circle to be described equal to the moon's semi-diameter. In this case,

Moon's semi-diameter = 16′ 8″·4,

or the points of first and last contact, M and T, may be found by making C M or C T equal to the sum of the semi-diameters of the shadow and moon.

The magnitude of the eclipse is measured by the ratio of the amount the innermost limb of the moon is obscured O B to the moon's diameter.

ELEMENTS.

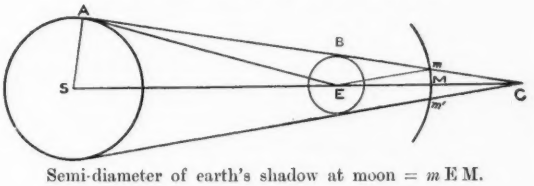
Eclipse of Moon, October 17th, 1902.

	H.	M.	S.
Greenwich mean time of opposition in R.A., October 16th	18	10	13·1
	°	′	″
☾'s Declination...	N. 9	8	52·8
☉'s Declination...	S. 8	55	20·5
☾'s Hourly motion in R.A.		34	34·7
☉'s Hourly motion in R.A.		2	20·0
☾'s Hourly motion in declination	N. 10		6·4
☉'s Hourly motion in declination	S.		55·2
☾'s Equatorial horizontal parallax		59	13·20
☉'s Equatorial horizontal parallax			8·84
☾'s True semi-diameter		16	8·37
☉'s True semi-diameter		16	3·15

Magnitude of Eclipse (Moon's diameter = 1) 1·463.

* Apparent semi-diameter of the earth's shadow at the moon; that this is the algebraic sum of the above quantities is shown as follows:—

S represents the sun.
E represents the earth.
m M m^1 represents part of the moon's orbit.



Semi-diameter of earth's shadow at moon = m E M.

m E M = E m A − E C m.
= E m A − (A E S − E A C).
= E m B + E A B − A E S.

But E m B = Moon's horizontal parallax.
E A B = Sun's horizontal parallax.
A E S = Sun's apparent semi-diameter.

Obituary.

RUDOLPH VIRCHOW.

By SIR SAMUEL WILKS, M.D., LL.D., F.R.S.

THE death of Professor Virchow has removed from the world of science one of its most devoted followers, and from the medical profession one who held the most eminent place in its ranks. Wherever scientific medicine was recognized the name of Virchow was as familiar as a household word. Pathology has as broad a basis as humanity itself, and so has united its cultivators in all parts of the world under one common master.

Nothing less than a volume could contain all the details of the life of this great man, as he was not only closely allied to the scientific world, but he held an important place in politics, possessing a seat in the Prussian Diet, as well as being a member of the Municipal Council which imposed upon him important hygienic work. At the present time, therefore, we can only regard the scientific aspect of the man, and even this

presents too large a view to allow me to do more than speak of him from a personal acquaintance which I enjoyed nearly forty years. Virchow was a Pomeranian, and was born at Schivelbein on October 13th, 1821. He distinguished himself at a local school and then proceeded to Berlin to study medicine. He joined an Institute connected with the University and obtained his practical knowledge at the Charité Hospital. He took his degree in 1843 and soon afterwards became an external lecturer on Pathology. At this time he was deputed to investigate an

Medallion cast in honour of Prof. Virchow on the occasion of his 70th birthday.

epidemic of fever, and his report so strongly reflected on the sanitary condition of the neighbourhood that it attracted much attention and criticism. His name also became associated with the Radical Party in Parliament, and thus he came into collision with the "man of Blood and Iron," and with other government officials. All this made his position as a teacher in the University very uncomfortable, and this being apparent, he was invited to accept the Professorship of Pathology at the University of Wurzbürg. This he did, and took advantage of the opportunity to devote himself entirely to the duties of his Chair. He made some very remarkable contributions to subjects connected with his work, which gave him at once a very prominent place amongst the scientific men of the day. His work was so carefully done, and his observations made with such perfect accuracy, that he was able to put forth his principles with the greatest confidence, and these being translated into different languages were seen to be the utterances of a master mind, and were at once accepted as the embodiment of truth.

His fame became so great that Berlin was only too ready to call him back, and the University to offer him the Chair of Pathology. This was in 1856, after a residence of five years at Wurzbürg. It was not long before he issued his great work, which made his name famous throughout the scientific world. This was the celebrated "Cellular Pathology." Its purport was to show how the cell was the unit of life, and that all growth proceeded from pre-existing cells. This was a substantial basis; a new and solid foundation, not only to explain morbid processes but healthy and physiological ones. The doctrine which was held at that time originated with Schwann, who, with the elaboration of the microscope, did much original work with respect to the ultimate tissues, both of the animal and vegetable kingdom. He taught that a fluid was thrown out from the blood, which he called the blastema; in this fluid a number of granules sprung up, which after a time formed themselves into groups or nuclei, and around these again the cell was formed. All cell life was thus produced in this cytoblastema. Virchow, by an unwearied study of years, completely upset this theory, and showed how every cell sprung from a pre-existing one. The cells afterwards became modified and altered to their respective forms, but in all cases they originated from parent cells. Just as the animal or plant is produced from one of a like kind, so do the individual cells composing them have a similar parentage. This was his great doctrine which was found to be true throughout the whole of living nature, and lies at the basis of all the laws of heredity. It was formulated by him into the sentence, "*Omnis cellula a cellulâ.*" This was an epoch-making doctrine, and will take its stand by Harvey's "Circulation of the Blood," Newton's "Law of Gravitation," or Darwin's "Origin of Species."

Besides the great work of Virchow, there are to be found in his "Archives," which he edited since the year 1847, numerous papers of great merit and originality. I may mention that of "embolism," the name he gave or adapted to the case where fibrinous matter is carried with the blood through the vessels until it blocks one of the smaller ones, as, for instance, an artery leading to the brain, when it leads to softening and paralysis. I might mention also his article on ulceration of bone, characteristic of a well-known specific disease. Virchow had a typical scientific mind, so that he said nothing that was not found to be absolutely correct and true—for example, in his work on tumours he refers to his examination of specimens in our English museums, and as regards that at Guy's, I found that he had appended the number which was written on the label to each example mentioned. Like Faraday, Darwin, and others of that stamp, he possessed in the highest degree a simple honesty of purpose. As showing his truly scientific turn of mind, I might quote his answer to those persons who wished him to investigate the miraculous case of a girl who had, every Friday, the bleeding stigmata appear upon her body. He said: "Every miracle exhibits a tendency which natural science does not. The miracle is produced with a determinate aim, seeks notoriety, stimulates attention, and advances to meet all mankind. Nature's laws are retiring, they have no interest in man, it being man who has an interest in the laws."

It may be mentioned that Virchow interested himself in everything appertaining to anthropology; and so he was enthusiastic in Schliemann's work in the Troad, and in 1882 he wrote a paper on old Trojan graves, and gave a description of the skulls found therein. It should be mentioned, too, that Virchow received from the Royal Society in 1893 the Copley medal, the highest honour it could bestow. France made him Commander of the "Legion of Honour," and he received distinctions from other countries, but no honour could add lustre to his name.

On reaching his 70th birthday a very remarkable ovation took place at Berlin to celebrate the occasion, and a medal was struck in his honour, and copies were made in gold, silver, and other metals. It had a diameter of 180 millimetres (7 inches), and the gold one weighed 2·3 kilograms (5 lbs.). On one side is a bust of Virchow surrounded by the inscription "*Rudolphus Virchow Pomeranus Civis Berolinensis. Ætat LXX.*" On the reverse is seen a female figure seated, representing anatomy, one hand resting on a book in her lap, and the other holding a skull. Science is represented by a male figure with wings holding a flaming torch over her head. In the background is the figure of Diana, a mummy, a skull, a microscope, a jar labelled "*embolia*," and other emblems of the arts and sciences. Written below are the words "*Omnis cellula a cellulâ.*"

The celebration of his 80th birthday took place on October 3rd of last year, when representatives of all nationalities crowded to do him honour at Berlin. It resembled no state ceremony, but was a spontaneous burst of homage from the civilized world. Lord Lister spoke on behalf of Great Britain, and said, that they joined in recognition of his gigantic intellectual powers and in the gratitude for the great benefits that he had conferred upon humanity, and in admiration of his personal character which was marked by absolute uprightness. Various places of learning sent him their congratulations.

Few men had so world-wide a reputation as Virchow, and,

therefore, everyone in England was glad to meet him, especially those who regarded him as their great teacher. He paid many visits to this country, and being a good scholar, made his speeches in English, but with considerable foreign accent. One of his most notable visits was at the time of the International Medical Congress in 1884. He joined with Sir James Paget, Huxley, and others, in giving addresses at St. James' Hall. He spoke on the value of experiments on animals, and concluded by asking the opinion of the company present on the question; the response as to their utility was carried without a dissentient voice.

Another very remarkable occasion was his visit to Edinburgh on the occasion of the tercentenary of the University, when its degree was conferred upon him. Some of the most learned men in Europe were there, but no one was more distinguished than Virchow.

On March 10th, 1893, Virchow was invited to give the Croonian Lecture before the Royal Society. The large room of the University of London was crowded to hear him deliver it; the subject being "The place of Pathology in Biological Study." In the evening a dinner was given to his honour at the Whitehall Rooms, Lord Kelvin being in the chair, and Sir James Paget and other eminent men made speeches to his honour.

On October 3rd, 1898, Virchow was invited to give the Huxley Lecture at Charing Cross Hospital. This was founded in honour of Huxley, who was educated there. The subject was "Recent advances in science, especially those bearing on Medicine and Surgery." This he delivered to a crowded audience at the neighbouring St. Martin's Hall. In the evening a dinner was given to him, presided over by Lord Lister. Being president of the College of Physicians, I was enabled to state the indebtedness of the profession to Dr. Chance for his admirable translation of the "Cellular Pathology," which brought this great work so soon before the profession in England.

On January 3rd of the present year he broke the neck of his thigh bone in alighting from a car. He soon recovered from the shock and went into the country, where his health much improved, although he did not expect to have the use of his leg again, for on examination by the Röntgen rays, he declared that no union could take place. Afterwards his strength began to fail, and he passed away on September 7th.

His remains were brought to Berlin and placed in the Rathaus, where they lay in state. On September 9th the funeral took place, a service was held, and the coffin then carried to the cemetery of St. Mathew's Church, followed by a procession a mile long. Besides the representatives of the University, many statesmen were present. Prof. Waldeyer delivered an oration on the part of science, and others followed in their different capacities.

A writer has said of Virchow, that he was the great pioneer of the obscurest of sciences, yet crossed swords with the chief of a political party, and also accomplished more social and administrative reform than any other man of his time; another writer that he was absolutely simple and devoid of self-consciousness, sincere, kindly, and unassuming; he was absorbed in his subject, the embodiment of accurate knowledge and sound judgment, the truest servant of truth.

British Ornithological Notes.

Conducted by Harry F. Witherby, f.z.s., m.b.o.u.

Black-eared Wheatear in Sussex.—A new species for the British list. At the meeting of the British Ornithologists' Club, held on June 18th last, Mr. W. Ruskin Butterfield exhibited a male specimen of this Wheatear or Chat, which had been shot near Polegate, Sussex, by a man named Williams on May 28th, 1902. Mr. Butterfield follows Mr. J. I. Whitaker in calling the bird *Saxicola caterinæ*, a name given to the western form of *Saxicola aurita*—the Black-eared Wheatear. It is at all events the western form of the bird which has now been recorded for the first time as having visited us. This form of the handsome and brightly coloured Black-eared Wheatear seems restricted to the South of Spain, North-west Africa, and Sicily, while the eastern form of the bird is found throughout the greater part of the South of Europe, Asia Minor, and North-east Africa. We are afraid that the present example is only a straggler, and we cannot expect this lovely species to make a habit of paying visits to these inhospitable shores.

The Starling as Foster Parent.—The somewhat singular incident of the Starling performing the duties of foster parent has been witnessed here; a female bird steadily feeding two young Song Thrushes, which follow her about most closely. The foster parent's duties are very carefully and studiously carried out.—W. Dunn, Withycomb, Exmouth.

Grey Lag-goose in Ireland.—A specimen of the south-eastern form (*Anser rubrirostris*) of the Grey Lag-goose was exhibited by Mr. F. Coburn at the June meeting of the British Ornithologists' Club. The bird was one of five received by the exhibitor from Limerick on November 23rd, 1901. One of the characters pointed out by Mr. Coburn as separating this bird from the Grey Lag familiar to English sportsmen was its longer and more slender body.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at the Office of* Knowledge, 326, *High Holborn, London.*

Notices of Books.

"Metallography: an Introduction to the Study of Metals, chiefly by the Aid of the Microscope." By Arthur H. Hiorns. (Macmillan.) 6s.—This book discloses the progressive nature of the study of metal structure by means of the microscope, and is the first complete handbook which has appeared on the subject. Articles by practical workers have constantly appeared in the various scientific journals, and there is actually a quarterly publication emanating from America which deals solely with this subject, but the volume before us gives in short but precise terms, not only the state of knowledge at the present time, but the methods of obtaining that knowledge. It cannot well be said that sufficient data and knowledge have been gained to class micro-metallography as an exact science, but such information as has already been obtained, has been of the most invaluable description, and this book will enable those who may be beginning, to start at the point at which advanced workers have arrived, and make those who are working in a more or less isolated manner, acquainted with the latest methods. The purpose of the microscopical examination of metals is admirably given in the writer's own words:—"It must be clearly recognised at the outset that microscopic examination is not intended, nor ever will replace chemical analysis or mechanical testing of metals. Its function is to add additional information of a kind which other methods are incapable of yielding. Thus, in steel, ordinary chemical analysis will indicate the total quantity of carbon, combined and free, but will not reveal the presence of definite mineral constituents, such as ferrite, cementite, pearlite, martensite, and the manner in which they are associated in the steel." Seeing that the whole study is dependent on the microscope being suitable for the work, it is somewhat singular that so small an amount of information regarding this instrument should be given. No real direction is provided to guide the beginner in his selection. Is, or is not, the raising and lowering of the stage by rackwork desirable? Should the objectives have large or small apertures, and have the apochromats proved more effective than the ordinary achromatics? Again, ought not the objective to be constructed specially to work on subjects having no cover glasses? These are points which one would expect to have elucidated, but the situation is summed up by the writer so far as the microscope stand is concerned, by the words, "the instrument should have a firm and fairly heavy stand . . . . . a mechanical stage is quite unnecessary." The instructions for photographing, and the illustrations, which are numerous, although they have evidently lost detail in the reproduction, are exceedingly instructive and interesting.

"Injurious and Useful Insects." By L. C. Miall, f.r.s. (Bell & Sons.) 3s. 6d.—All teachers of economic zoology must feel grateful to Prof. Miall for this excellent little book, from which a student can hardly fail to learn how to observe, think, and act for himself. It opens with an account of the Cockroach

as a typical insect. Then come full descriptions of some thirty selected common insects of various orders, attention being given to their form, life-history, bionomics, and practical importance, as useful or harmful to the farmer or gardener. This section occupies the greater part of the book, and is followed by a short summary of the insect orders and their more important families. Finally, the author gives a section on the "Destruction or Mitigation of Insect Pests," placing before the student some general principles to guide him in his economic work and relating in detail the successful struggles of American entomologists against the "Gipsy Moth" and the "Fluted Scale." The style of the book is beautifully clear, and the facts are set forth so as to attract and fascinate the student. He is led to study an insect practically, and encouraged to look for the reasons of what he observes. The accounts of the life-histories are constantly lighted up with bright flashes of suggestion. "Why," asks the author, "has the female Vapourer Moth no wings?" He points out that first of all we need to ask, "Why insects fly at all"; and thus we are led on to a fruitful discussion of the relative importance of the larval and perfect stages in securing the spread of an insect species. Everywhere is pressed home the lesson that the successful mitigation of insect pests depends upon our knowledge of their life relations. The book cannot fail—in the full sense of the words—to educate naturalists.

IN answer to many enquiries, the publishers of KNOWLEDGE state that Mr. E. W. Maunder's book, "Astronomy without a Telescope" (which also contains the articles on "Constellation Studies") will be ready about the middle of October. A large portion of the work has been rewritten.

BOOKS RECEIVED.

Elements of the Theory of the Newtonian Potential Function. By B. O. Peirce, PH.D. (Boston and London: Ginn & Co.) 12s.

Beasts of the Field. By William J. Long. (Ginn & Co.) Illustrated. 7s. 6d.

Fowls of the Air. By William J. Long. (Ginn & Co.) Illustrated. 7s. 6d.

The Common Spiders of the United States. By James H. Emerton. (Ginn & Co.) 6s. 6d.

Our Country's Fishes and How to Know them. By W. J. Gordon. (Simpkins.) Illustrated. 6s.

Zoological Results based on Material from New Britain, New Guinea, &c. By Arthur Willey, D.SC., F.R.S. Part VI. (Cambridge University Press.) Illustrated.

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. 4th Edition. Revised and corrected. (A. & C. Black.) Illustrated. 15s.

The Foundations of Geometry. By David Hilbert, PH.D. Translated by E. J. Townsend, PH.D. (Kegan Paul.) 4s. 6d.

On the Distribution of Rain over the British Isles during the Year 1901. Compiled by H. Sowerby Wallis and Hugh Robert Mill, D.SC., LL.D. (Stanford.) 10s.

Electrical Installations. By Rankin Kennedy, C.E. Vol. II. (Caxton Publishing Co.)

Induction Coils for Amateurs. Edited by Percival Marshall. (Dawbarn & Ward.) Illustrated. 6d.

P. O. P. By A. Horsley Hinton. (Hazell.) Illustrated. 1s.

The Journal of the Anthropological Institute of Great Britain and Ireland. Vol. XXXII. Published by the Institute. 10s.

Proceedings and Transactions of the Meteorological Society of Mauritius. Vol. II.

NOTES.

ASTRONOMICAL.—Six spectroscopic binaries, in addition to the thirty-two previously announced, have lately been discovered at the Lick Observatory, namely, ϕ Persei, η Geminorum, γ Canis Minoris, ζ Herculis, α Equulei, and o Andromedæ. Including three stars of this class detected by Belopolsky, Prof. Campbell points out that out of 350 stars observed, one in eight is a spectroscopic binary, while many others are suspected. He also expresses the opinion that as the accuracy of measurement becomes greater, the star which is not a spectroscopic binary will prove to be the rare exception. The instruments for continuing the work in the southern hemisphere have been completed, and it is hoped that the expedition may be able to sail in the near future for Valparaiso, to occupy a station near Santiago, Chili. Mr. D. O. Mills has again shown his appreciation of the work of the Lick Observatory by a gift of a thousand dollars for improvements of the Mills spectrograph, and Mrs. Hearst has presented a sum of 2500 dollars to increase the equipment of the Observatory. It is announced that copies of any of the photographs taken at the Observatory may now be obtained at moderate expense on application to the Director.

The discussion of the connection between the variations of terrestrial magnetism and solar activity has chiefly been confined to comparisons of magnetic phenomena with sunspots, and it is well known that while the diurnal range corresponds closely with the sunspot cycle, a difficulty has arisen from the fact that a great sunspot may or may not be accompanied by a magnetic storm. Sir Norman Lockyer has recently investigated the magnetic variations in relation to the observations of the chromosphere and prominences made by the Italian observers during the last thirty years, and has concluded that the epochs of great magnetic storms correspond with those of the greatest disturbances of the chromosphere near the sun's poles, while the general magnetic curve agrees closely with that of prominences observed near the solar equator.—A. F.

BOTANICAL.—*Torreya* for August contains, in a note by Dr. M. A. Howe, some interesting information on the vitality of the spores of *Marsilia*. Prof. D. H. Campbell proved several years ago that the spores of *M. ægyptiaca* may germinate when twelve years old. Some spores which he obtained from dried specimens preserved for that period in the Berlin Botanical Museum germinated within thirteen hours after being placed in water. He found that in the case of spores eleven years old fifty per cent. germinated, and of those five years old nearly all grew. According to Prof. Barnes, spores of *Marsilia quadrifolia* retained their vitality after being kept for three years in commercial alcohol. Dr. Howe has experimented with spores procured from material which had lain in the herbarium for periods varying from twelve to thirty years. The oldest spores which grew were practically eighteen years old, and belonged to *M. vestita*. Nearly all the megaspores formed prothalli with archegonia, and practically all the microspores reached an advanced stage of germination, though only about half set free motile spermatozoids. The first of these were seen in eleven and a quarter hours after the sporocarps were placed in water.—S. A. S.

ENTOMOLOGICAL.—A Centipede of quite exceptional interest has been described (*Quart. Journ. Micr. Sci.*, Vol. XLV., 1902, pp. 417-448) by Mr. R. I. Pocock. It was discovered on the summit of Mount Romney, Hobart, Tasmania, and it "proves to be comparable in interest to either of its compatriots Ceratodus or Ornithorrhynchus, as it unmistakably represents an archaic type which has survived in this isolated corner of the world." The species (*Craterostigmus tasmaniensis* by name) possesses fifteen pairs of legs, like our own well-known Lithobii, but it differs from all other known centipedes in having more tergites than sternites in its skeleton. There are fifteen of the latter, corresponding with the pairs of legs, but twenty-one of the

former. Now, as the large tropical centipedes—Scolopendra and allies—have twenty-one (or twenty-three) leg-bearing segments, Mr. Pocock concludes that this Tasmanian form represents a connecting-link between the Scolopendrids and the Lithobiids, six sternites, with their accompanying pairs of legs, having vanished, but the tergites still remaining. We get thus a most suggestive clue to the method of evolution among the centipedes.

An account of the life-history of the beetle *Clythra quadripunctata* is given by Mr. H. St. J. K. Donisthorpe (*Trans. Ent. Soc. Lond.*, 1902, pp. 11-25). The female beetle drops her eggs on the ground near nests of the Wood Ant (*Formica rufa*), and as the eggs are enclosed in cases formed of the mother's excrement, which give them the appearance of small bracts, the ants carry them into their nests. The grubs feed on vegetable substances contained in the nest, protecting themselves by building up hard, insoluble cases of excrement. When a beetle emerges from the case at the end of the pupal stage, it creeps stealthily out of the nest, stopping and "feigning death" if approached by the ants, which seem to behave in an unfriendly way to this "guest" both in the larval and perfect states.—G.H.C.

Zoological.—Professor Ray Lankester's long-expected memoir on the okapi of the Semliki Forest has been issued in the *Transactions* of the Zoological Society, forming the sixth part of Vol. XVI. It is illustrated by a coloured plate drawn from the presumably immature specimen in the British Museum, and numerous text figures of skulls, etc. Fortunately, the Belgian specimens, which prove the occurrence of horns in the okapi, arrived in this country in time to receive a brief notice in Prof. Lankester's memoir. The probable affinities of the animal are discussed in considerable detail by the author. It may be well to notice that in the fourth line from the bottom of page 287 the word *incisor* should be *canine*.

To the *Proceedings* of the Royal Society (Vol. LXX., No. 465) Messrs. Alcock and Rogers communicate an interesting paper showing that the saliva of many reputedly harmless Indian snakes has poisonous effects when injected into the blood of small mammals. And they are enabled to indicate a gradation, so far as toxic properties are concerned, from species like the rat-snake, in which the teeth are solid cones, through other kinds with teeth channelled behind, to the deadly cobra and its kindred, in which the fangs have assumed the form of hollow cones for the conveyance of the venom from its receptacles.

Dr. R. Lehmann-Nitsche, of the La Plata Museum, has recently published in the German *Archiv für Anthropologie* (Vol. XXVII., Art. 19) the evidence for regarding the extinct Patagonian ground-sloth, of which the skin and other remains were discovered a few years ago in a cavern at Last Hope Inlet, as a contemporary of the ancient cave-dwellers of the country, by whom indeed these animals appear to have been domesticated.

With the exception of a few elephants' teeth and bones, vertebrate remains appear to have been hitherto unrecorded from Japan. The appearance of a memoir in the *Journal* of the Tokio College on a fossil Japanese mammal of presumably Miocene age is, therefore, a matter of considerable interest, more especially as the remains appear to indicate a form quite unlike any known from other parts of the world. The authors of the memoir regard the fossil as referable to the elephant group, but it is quite likely that this determination may be called in question.

Dr. J. Wortman has been re-examining the magnificent series of American Eocene carnivora collected by the late Prof. Marsh, and has published the results of his investigations in the *American Journal of Science*. He is of opinion that the primitive mammals known as creodonts should be included among the carnivora, and also that they are closely related to the marsupials. But he refuses to accept the modern view that marsupials themselves are the descendants of placentals; and inclines to the opinion that both creodonts and modern marsupials are derived from a non-placental stock. How, on this view, we are to explain the occurrence of a vestigial placenta in the bandicoots, the author does not say.

In a memoir issued by the Survey Department at Cairo, Messrs. Andrews and Beadnell give a preliminary description of new forms of extinct mammals from the Fayum district of Egypt. Perhaps the most remarkable is an imperfect lower jaw furnished with a pair of serrated and recumbent incisor teeth, which they regard as probably representing a new type of carnivora, and name *Phiomia serridens*. To the same is provisionally assigned the front part of an upper jaw with a single pair of large tusk-like incisors. Very interesting is part of an upper jaw described as *Saghatherium antiquum*, which seems to indicate the oldest representative of the hyrax group at present known. Another mammal from the same deposits is assigned to the widely-spread Tertiary genus *Ancodus*—one of the transitional forms between pigs and ruminants. The authors are now of opinion that the beds containing remains of the genus last mentioned, together with *Arsinotherium*, *Palæomastodon*, etc., are of Upper Eocene age, while the underlying deposits with *Mœritherium*, *Bahytherium*, etc., are Middle Eocene. Below these come other beds from which have been obtained remains of the primitive cetacean *Zeuglodon*.

THE BIOGRAPHY OF A SNOWFLAKE.

By Arthur H. Bell.

It is one of the most interesting things in connection with the subject of the weather that all its phenomena are so closely in touch with one another, and that in order to explain any one of them it is necessary to take account of all the rest. A further fact is that the various phenomena have a power of transforming themselves very quickly as it were into something else, so that it is often a long process to hunt down and discover what is the fundamental structure of these fugitive shapes. A snowflake, for instance, at first sight might be thought to have a separate existence from any of the other children born of aqueous vapour, but on attempting to follow up the history of these "frozen flowers," as Professor Tyndall called them, it is found that the attention is at once directed to the consideration of such things as rain, hail, sleet, mist, dew, hoar-frost, and clouds. Hail, rain, sleet and snow are, of course, very nearly related indeed, but similarly to the other phenomena they are all built up out of aqueous vapour, and when vapour is condensing out of the atmosphere it is, at some seasons of the year, quite as likely to take one shape as another. Of the phenomena mentioned above hail is probably the most noisy in its descent from the atmosphere to the earth, and this more especially when it happens to be accompanied by a thunderstorm. On the other hand hoar-frost and snow are probably the quietest of all the children of the air, while as regards their picturesque effects, who would venture to decide between two such skilful artists? Snow, which is the parent of the grinding glacier and the stupendous iceberg, has, however, such notable effects on climate and on weather that few meteorological phenomena can compare with it for interest.

Now it is probable that, as is the case with a raindrop, or with hail, in order to give a snowflake a start in life there must be a tiny nucleus of dust, round which the condensing vapour may gather. It is mainly a question of temperature as to what form this condensing moisture will take, but commonly when the temperature is above the freezing point rain is the outcome. When this process takes place in a body of air at or about the freezing point, snow gets its opportunity; while when the condensed moisture does not at once freeze solid, hail will be more likely to occur. At some times, indeed, both snow and hail take the form of little fluffy pellets of frozen moisture, and considerable experience is necessary to distinguish between them. As a general rule, the colder the weather the smaller the snowflakes; the large flakes, which children describe as being due to the old woman plucking her geese, appearing when the thermometer is not far away from the freezing point. Large flakes, indeed, are a conglomeration of smaller flakes, and it is in the latter that the greatest regularity and beauty of structure are to be seen.

In order therefore that a snowflake may make a successful journey through the atmosphere it should be built up on a particle of dust, while if it should be fortunate enough to commence its career at the top of a cloud soaring many miles above the level of the earth, it will thereby become still better equipped for adding to its stores of frozen vapour. Between the growing snowflake and the earth, it should be borne in mind, there are in ordinary conditions strata of atmosphere that differ very much as regards their temperature, and the amount of moisture they contain. These different layers through which the descending snowflake will pass favour its development, for it often happens that in one layer of atmosphere the flake gathers moisture which is promptly frozen in the succeeding layer. In this connection it is well to recall what happens when one holds a snowball, or two pieces of melting ice in a warm hand for any length of time, for either can be welded into a solid lump by a little pressure, a process commonly called regelation, and to be borne in mind when seeking for the causes that favour the growth of a snowflake.

From each layer of atmosphere through which it passes the fluttering snowflake may therefore be thought of as collecting a tribute of moisture, but unlike a hailstone it makes these accretions in gentle fashion. There is a fuss and a dash with the downward plunge of a hailstone, so that the frozen moisture is welded around it with great force and it quickly grows hard and solid. On the other hand, with a snowflake the frozen moisture is not so much welded as it is enmeshed, for on every snowflake, even in its early moments, there are protuberances and spicules that catch the floating moisture as in a tiny net. The most common forms of snowflake have a solid nucleus with rays ramified in different planes, others taking the shape of six-sided needles or prisms, or six-sided pyramids. A complicated snowflake takes the form of a six-sided prism from one or both ends of which six-sided plates are projected. Another kind of snowflake is found to be simply a thin lamina of frozen moisture, snowflakes of this class being observed in great variety. Many interesting sketches have been made of all these different kinds of snowflakes, but this is work that requires further elaboration by some observer willing to devote a little time to this most interesting work of taking a picture of the snowflakes as they reach the earth. It has been said that the crystals in any given snowstorm have a family likeness, each storm, as it were, having its own particular type of snowflake. This is an interesting point to be settled only by careful observation, and for the present it is enough to recognize the fact that although snowflakes seem all very much alike yet there is endless variety in these "lovely blossoms of the frost."

It will be seen, then, that the conditions most favourable for the production of large snowflakes are when the atmosphere is freezing in some parts and thawing in others. With these conditions the process of regelation of moisture on the surface of the snowflake will proceed apace. Under such favourable circumstances very large flakes may be built up, although, as already mentioned, these large structures are often but the result of flakes that have collided in mid air and joined forces. These large snowflakes are like very large hailstones, which are often but a mass of ice formed by several hailstones crushed together. Both as regards the snowflake and the hailstones, these conglomerates are not properly to be taken as showing to what size a single flake or stone may grow. With this proviso it may be stated that one of these conglomerate snowflakes was found to measure $3\frac{1}{2}$ inches in length, $1\frac{1}{2}$ inches in breadth, and $1\frac{1}{2}$ inches in thickness; the flake when melted yielded $2\frac{1}{4}$ cubic inches of water. Such large snowflakes as this cannot come to maturity when the atmosphere is of a very low temperature all through. In such circumstances there are no alternate layers of air of varying conditions in temperature and moisture, and as a result only small, dry flakes of snow are produced. This is the kind of snow that falls in the polar regions, and it is these cold weather snowflakes that are the most perfect in form. Closely allied to the small and the large snowflakes is sleet. This commonly is objurgated as the most unpleasant of all the children born of the atmosphere, but it will perhaps be seen that rightly to understand the whole story of a snowflake, something of the changes in temperature that produce sleet need to be taken into account.

When lying on the ground, snow, from a meteorological point of view, is of much greater interest than when falling through the air. In an ordinary way there is a constant exchange of heat between the surface of the earth and the atmosphere. Thus during the day the sun pours its warmth down through the air to the earth, so that the surface of the ground is raised in temperature. During the night hours this acquired warmth is rapidly radiated into space, and the temperature of the earth accordingly falls. The atmosphere, moreover, that is everywhere in the closest intimacy with the ground, is also affected by this prodigal behaviour of the earth. Now, when the ground is wrapped round in its mantle of snow, these imports and exports of heat to and from the earth are interrupted. In other words, the diurnal range of temperature is greatly modified, so that all the time snow is on the ground there is not that excessive expenditure of heat that ordinarily takes place, and as a result the soil beneath the snow is maintained at an equable temperature.

Anyone who has been on the snow a few thousand feet above the level of the sea will have recognised the fact that snow is a good radiator of heat. At such a height, moreover, the atmosphere is dry and free from dust, so that as the heat rays pass through the air, to and from the surface of the snow, they have but little effect as regards raising the temperature of the air. Air such as this is said to be diathermanous, and heat rays passing through such territory, so to speak, pay no toll. Similarly snow, so long as it remains clean and free from impurities, reflects the heat rays, but will not absorb them. Supposing, however, that a little dirt or a plentiful supply of coal-dust settles on such snow, heat is at once absorbed, and the "frozen flowers" are destroyed. That the snow is white is considered to be due to the fact that the ice crystals of which each individual snowflake is built up, act as so many miniature prisms that blend the prismatic

colours and so scatter a white light. In its embrace also, each snowflake as it lies upon the ground, holds a tiny supply of air, and it is this circumstance that makes the snow so bad a conductor of heat. Snow then in regard to the earth and the atmosphere acts as a buffer state, so that it passes no heat down from above and allows none to travel upwards from below.

Further, not only is snow of interest in the manner of its birth and in respect of its sojourn on the earth, but its actions are no less entertaining when it melts. In passing it may be observed that one foot of snow is considered to be equal to ten or twelve inches of rain. When, therefore, snow is on the ground to the depth of several feet there is an enormous quantity of moisture held in suspension. It is not surprising then that when a sudden thaw sets in, the water courses and rivers are unable to carry off the melting snow, and that floods result. At times, too, it will happen that the ground in the neighbourhood of fallen snow is frozen hard, so that as the snow melts it rushes impetuously onwards, disastrous floods being again produced. When the snow disperses in orderly fashion it percolates through the ground, and it will readily be understood that as the cold icy water passes downwards notable modifications occur in the temperature of the soil. At such times undrained land becomes saturated with the chilly water, and for this and other reasons it has been observed that the effect of draining land is the same as if it had been removed one hundred miles to the southward. It is not, therefore, surprising that in many countries considerable attention is given to the work of observing the snow, so that ample warning may be given to those whom it may concern of the time when it is beginning to melt.

Both when on the ground and when it melts it will therefore be seen that snow is constantly modifying the temperature of its surroundings. On the winds also which blow to and from the snow-covered areas these changes have also their effects, so that in studying climatic conditions it is imperative to know the times and seasons when a given locality is covered with snow. As already mentioned, to follow the biography of a snowflake to the end, something should be said concerning glaciers and icebergs; but it is sufficient for present purposes to call attention to them, with the observation that they were built by the snowflakes.

VEGETABLE MIMICRY AND HOMOMORPHISM.—V.

By Rev. Alex. S. Wilson, M.A., B.Sc.

The resemblance of *Aserŏe Junghu* to a sea-anemone was referred to in a previous article; this fungus attains a diameter of about a foot, is conspicuously coloured, and like Phallus, emits a fœtid odour; the gleba at its margins splits up into long narrow segments, which closely correspond to the tentacles of the zoophyte. The plant is a native of Java. Another remarkable member of the same family is the tropical Dictyophora, which is not unlike the common stinkhorn in shape, but is surrounded by a delicate white network which hangs expanded below the cap like a crinoline. This appendage, like the white corolla of a night-flowering plant, increases the conspicuousness of the fungus after dark. The Phalloidi occupy a somewhat exceptional position among fungi. Only some seven or eight per cent. of agarics, as Mr. Wemyss Fulton points out, are attractively coloured, seventy-four per cent. being brown, slaty or black. Ninety-one per cent. of the Phalloidi on the other hand, are red or white, warranting the conclusion that these colours are attractive to flies, which affect putrid substances. For this reason the Phalloidi are sometimes designated the "Flowering Fungi." This is the light in which Mr. Fulton also views the colours of the Amanitas, Mycenas and a number of the smaller agarics. Even the odour of putrefaction itself, he thinks, may be meant to

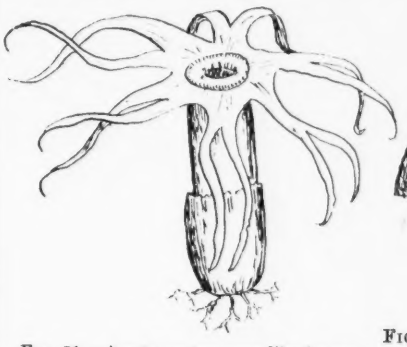


Fig. 21.—Aserŏe, an anemone-like fungus.

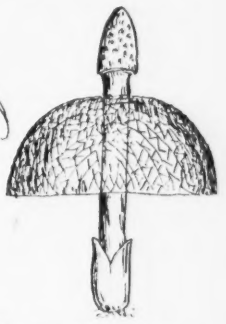


Fig. 22.—Dictyophora, a flowering fungus.

attract flies which aid in the dispersion of putrefactive bacteria. Some of the marsh bacteria give rise to a jelly which floats as scum on pools and ditches. The beautiful rose-pink tint of this jelly which is full of these organisms may not improbably also be of use in promoting their dispersion. The attractive characters observed in fungi as a whole remind us of those flowers which are adapted to the visits of flies, beetles and other short-lipped insects. Gaily attired insects like the drone-flies manifest a preference for the more handsome blossoms, and are the most frequent visitors of the saxifrages, speedwells and forget-me-nots. The beautiful amethyst Clavaria seen amidst its surrounding of moss impresses the observer with the idea that this fungus lays itself out to attract the same class of visitors. Insects which themselves emit an odour likewise manifest a fondness for strongly-smelling flowers; the odoriferous bee Prosopis, for example, shows marked partiality for the strongly-scented flowers of rue and mignonette. The offensive odours of the Phalloidi, though specially attractive to flies, are in all probability repugnant to ruminants.

Numerous examples of interfungal resemblance have been described, and though most of these may be merely homomorphic, it is highly probable that at least some of them may be truly mimetic. Many years ago Mr. Worthington Smith directed attention to three British fungi which so closely resemble certain common species that minute examination is necessary to detect the difference. One of the species thus copied is bitter and nauseous, so that possibly the rarer kinds escape discovery by being mistaken for distasteful species. At least twenty species might be named, each of them closely simulated by another species. Dr. Plowright gives a list of twelve edible fungi, each imitated by one or more poisonous species. The Caesarian agaric, esteemed a delicacy in Italy, is copied by the poisonous amanita, or *vice versâ*, for it is not always possible to say which is the original and which the copy; the common mushroom has at least three imitators with poisonous properties—*Ag. melaspermus*, *Ag. fastibilis*, and *Ag. Taylori*; one can easily understand how fatal mistakes occur. Some of these resembling fungi are no doubt closely related, but in others the relationship is more remote, as in the case of a small agaric, referred to by Dr. Cooke, which

resembles *Ag. cucumis* in a remarkable way and grows in the same situations. Both have the identical odour of decaying fish, but as the spores of the former are red, while those of the latter are white, they are classified in distinct and separate groups.

It has frequently been asserted that the spores of the common mushroom do not germinate unless they have been swallowed by some warm-blooded animal. Although this is denied by competent authorities, the fact remains that agarics are eaten by horses, cattle, sheep, squirrels and other animals. The partiality of certain fungi for animal droppings also favours the idea that some species at least are benefited in this way. On this assumption a poisonous species would profit by its resemblance to an edible species. On the other hand a conspicuous species with unwholesome properties might afford a model which edible species might copy with advantage, if their spores were incapable of withstanding the action of digestive fluids.

It is held by some that the function of the cystidia which occur along with the basidia on the gills of agarics is to fertilise the spores, and that to secure cross-fertilisation insect agency is necessary. This theory is by no means established, and in the present state of our knowledge it is impossible to say with any confidence whether the attractive characters of agarics promote dispersion or fertilisation or even to be sure that they are serviceable in any way.

The conditions under which plants live are not indeed such that the same amount of protection is required as in the case of animals, and it is hardly to be expected that their imitative powers should equal those of the animal world either in the extent to which deception is carried or in the variety of disguises assumed. The facts we have considered are sufficient, however, to show that in the two kingdoms of organic nature we have to deal with essentially the same phenomena.

The advocates of natural selection have constantly appealed with the utmost confidence to the evidence from mimicry in support of the theory, but this line of proof is by no means so convincing as has been supposed. No doubt the green colour of caterpillars may be easily accounted for by the extermination of the individuals which happened to be otherwise attired. Many facts, however, indicate that the explanation is not quite so simple; this line of reasoning would certainly lead us into error in the case of the flat fishes. When a flounder is transferred from a tank with sand to one with a gravelly bottom spots at once appear on the fish harmonizing with the gravel, due apparently to reflex action arising from an alteration in the light rays. Nature even seems to possess the secret of photographing in colours, for the pupae of several butterflies acquire the colour of the box in which they are kept. Accordingly Mr. A. R. Wallace, while attributing true mimicry as we have it in the butterfly Leptalis to natural selection, is constrained to refer the general similarity of tint to their surroundings which so many animals exhibit, to the action of light rays reflected from the environment. Our recently acquired knowledge of the Röntgen rays and their effects is not without a bearing on the question at issue. Many substances are known to emit invisible rays capable of giving rise to changes in the molecular arrangement of organic bodies. There can be little doubt therefore that the influence of radiant matter on the highly complex and plastic substances of living bodies has played an important part in bringing about those remarkable resemblances which are included under the terms mimicry and homomorphism. Such considerations do, however, detract very seriously from the value of natural selection as a factor in organic evolution; so far as mimicry is concerned there is little left for natural selection to do, only the finishing touches, so to speak.

The phenomena of homomorphism are also to some extent adverse to the Darwinian theory. If we assume with Darwin that variation is fortuitous the law of probabilities forbids us to expect coincidences like that observed in the orchids and asclepias. In dealing out cards, for example, the chances against a player receiving the same set a second time are very great, and the improbability increases in a geometrical ratio as the number of cards is increased; with a large number of cards the improbability is infinitely great. There is the same kind of improbability and that in a high degree against the production through fortuitous variation and natural selection of those coincidences which are so frequent in the organic world. Darwin felt the force of this objection, which he met by saying—"As two men have sometimes independently hit upon the same invention, so it appears that natural selection working for the good of each being and taking advantage of all favourable variations has produced similar organs, as far as function is concerned in distinct organic beings which owe none of their structure in common to inheritance from a common progenitor." But this reply does not quite dispose of the difficulty; the two cases are not strictly analogous; to make them parallel we should have to suppose that two men accidentally and quite unintentionally alighted upon the same invention—a rare occurrence indeed. Yet such a supposition is necessary in order to eliminate the element of intelligent investigation on the part of the two inventors, to which there is nothing corresponding in natural selection. When two similar variations have arisen natural selection sufficiently accounts for their preservation; the difficulty is the appearance at two or more points of the organic system of identical variations. That this has occurred again and again goes to show, either that the environment has exercised a definite influence in generating particular variations, or that there is in organisms an innate tendency to vary along certain lines. In any case variation cannot be fortuitous, but must have its course dominated by fixed, though it may be unascertained laws. There is profound biological truth in Emerson's words: "Nature's dice are always loaded."

But a still wider question confronts us. If resemblances can arise among organisms apart altogether from hereditary relationship what, it may be asked, becomes of the argument for organic evolution based on similarity of structure? If, as Darwin admitted, the eye of a cuttle-fish and the eye of a vertebrate had an independent origin, may not the same thing hold good in regard to many of those likenesses to which evolutionists appeal in support of their theory? Homomorphic is differentiated from hereditary resemblance by the absence of connecting forms. The evolutionist postulates the former existence of innumerable intermediate forms. If these never had any existence then the alternatives are either evolution *per saltum* or independence of origin. Between the inorganic and the animate no intermediate forms are conceivable; we are therefore compelled to assume an independent origin for life. And although we cannot form a definite conception of such an occurrence, few naturalists nowadays will be satisfied with a single primitive type as the original source of all the manifold forms of life. But whatever view we may hold on this point, it is impossible to conceive of the successive advances in the organization of plants and animals which have taken place in past geological time apart from corresponding accessions of vital energy.

Conducted by M. I. Cross.

Pond-life Collecting in October.—October is one of the best months for the pond-hunter; the weather is cooler, the ponds have become filled with rain-water again, with plenty of food material in the shape of flagellate Infusoria, and the Crustaceans are on the decline. In this month the greatest variety in species of Rotifera is usually found, particularly of the smaller and rarer kinds, and not infrequently thirty to forty species may be obtained in one or two small ponds. As a general rule one cannot expect much variety when a few species are present in excessive abundance. The following is a list of forty-four species of Rotifers actually collected on one occasion in three ponds on October 15th, 1898, showing what may be looked for:—*Floscularia regalis*, *ornata*, *cornuta*, *ambigua*, *edentata*, and *annulata*; *Limnias annulatus*, var. *granulosus*; *Oecistes crystallinus*; *Philodina megalotrocha*; *Rotifer vulgaris*; *Synchaeta tremula* and *oblonga*; *Asplanchna priodonta*; *Notops hyptopus*; *Polyarthra platyptera*; *Eosphora aurita*; *Furcularia longiseta*, *sterea*, and *forficula*; *Proales felis*; *Diglena biraphis*; *Mastigocerca rattus* and *bicornis*; *Coelopus porcellus* and *tenuior*; *Rattulus bicornis*; *Diaschiza exigua*; *Distyla flexilis*; *Monostyla lunaris*; *Dinocharis pocillum*; *Stephanops lamellaris*; *Cathypna luna*; *Euchlanis oropha*; *Metopidia acuminata*; *Brachionus angularis* and *bakeri*; *Pompholyx sulcata*; *Notholca labis* and *scapha*; *Anuraea aculeata*, *cochlearis*, *tecta*, *hypelasma*, and *stipitata*. On the other hand, the various kinds of Rotifers known as summer forms will now have disappeared. *Pedalion mirum* is such a form which may occasionally still be seen during a warm October, but is then usually very scarce or absent.

Microtomes (*continued*).—It is impossible to give descriptions of all the different microtomes, even if one eliminates those that do not possess special merit or qualities. It will only be possible to name two or three, and if further information is required about them it can be obtained from any of the usual dealers.

Leitz and Reichert both make good sound microtomes, the latter having a high reputation for his continuously working micrometer screw upon the rivet model. This continuous working is brought about by simple means, viz., when the screw has reached the limit of its movement, it is turned through 180° so that its opposite extremity points towards the object-holder, when the working can at once be continued.

The Minot microtome for the paraffin ribbon method, by Zimmerman, of Leipzig, is a very excellent form, and Becker also makes one on the Schanze and Minot models. The former is worked by rotating a balance wheel, whose rotary action is changed into a vertical movement of the object slide by means of a crank action. When the object slide is moving upwards, a lever strikes one of the spokes of the rachet wheel which, in turn, moves the large toothed wheel of the horizontal micrometer screw, thus advancing the object towards the knife; it works with great rapidity, and cuts sections up to 2 × 2″ with exactness and absolutely flat.

The Reinhold Giltay model has points of both ingenuity and originality; it is constructed for the paraffin process. It is mounted upon an iron stand with a wooden cover, in a similar manner to a sewing machine; the working parts are compensated for wear and tear, and it is constructed on similar principles to the Minot from which it differs in the feed adjustment. This is effected by the slide of the knife block towards the object by means of a micrometer screw passing through the block, the movement of the object being restricted to the vertical direction.

The microtomes of Schanze, of Leipzig, have many features which may fairly claim for them special attention and favour; they are second to none in accuracy and beauty of workmanship, and are unexcelled for general utility.

In order to do work with the microtome, there is certain accessory apparatus which is necessary, and on which will materially depend the success or failure of the early experiments. Knives will have to be selected, and the beginner will find a bewildering number of patterns from which to make his choice. For general paraffin cutting with sledge microtomes, the Henking pattern knife, having a blade 6 cm. long and the handle 9 cm. long, is probably the best. Jung's pattern, in which the blade fits into an ebony screw handle is another useful form. It may be employed for cutting at right angles to the microtome guides or obliquely, with a slicing cut, provided that the knife is of suitable size for the microtome.

Other patterns in use are Weikert's, with a straight handle, and both sides of the blade concave for cutting celloidin embedded objects under fluid; and Thoma's, or the Heidelberg pattern, with a curved handle having the underside flat and the upper side concave. The latter does the same work as the Jung pattern already referred to, but does not require a special holder, as it fits directly to the carrier of the microtome.

The sharpening of the knives is a very important process, and, excepting this is carefully attended to, it is utterly impossible to cut good sections. Some brief instructions on these matters appeared in Knowledge, July number.

A few words may be added to emphasize the necessity for the proper preservation of the objects that are to be cut into sections. Living organisms or parts of them must be taken at the time of robust health and killed and fixed instantaneously, with the substances best suited for obtaining the desired results. All the fixatives known to science will not preserve the lifelike stages in the histology of the subject when once post-mortem changes have taken place. The subject of fixing, embedding in celloidin and paraffin, staining *en bloc*, and mounting generally, are so fully treated in books on these specific subjects that the space available in this journal will not admit of treating each of the processes in detail.

There is one important point, however, with regard to paraffin for embedding; different writers disagree as to the melting point of the wax that should be used; as a matter of fact, all grades are useful, and the melting point of the paraffin will depend on the temperature of the laboratory in which the work is done and the thickness of the sections required. If the room is 15° C., and sections are required 10 μ thick, paraffin with a melting point of 45° C. will be suitable; but for sections 5 μ thick with the same room temperature, a higher melting point of paraffin must be employed, say, 48° C. or 50° C., and for sections 1 μ thick, and the same room temperature, the wax must have a still higher melting point, and *vice versâ*.

If the paraffin is too soft for the temperature of the work-room and thickness of sections, then the sections will probably crumble together; if the paraffin is too hard the sections will curl or roll upon the knife.

System in this work, as in everything else of so precise and delicate a nature, is the one important thing; nothing must be done in a hurry, but every stage carefully arranged for and anticipated.

Practical Scheme.—Through the courtesy of a reader we are able to offer to such as may wish to avail themselves of it, material for distribution.

It consists of Basal Reef Rock, containing a variety of organisms living in comparatively shallow tropical waters, probably in Pliocene time, as well as interesting inclusions of the older oceanic beds:—Globigerina in rock; Radiolaria in rock; Diatoms in rock. These should properly be ground for microscopical examination.

The supply is not a very extensive one, but it is of special interest, and will be forwarded to applicants on receipt of stamped addressed label, together with the coupon which will be found in the advertisement pages.

NOTES AND QUERIES.

J. S.—The light-dispersing power of the glow-worm has been attributed to several causes. It was at one time thought to be caused by phosphorous, but this theory has not been confirmed by later researches. Some experiments have been conducted by a French naturalist, who proved that the illumination is used as a means of signalling between individuals of the same species. He placed a glow-worm in a glass tube, but it emitted no light until others of the same species approached; then to attract their attention it emitted jets of light in rapid succession.

XUM

These were responded to by the other insects and the moment the imprisoned one was assured that it had attracted the attention of the new comers, it ceased to emit light.

Lt. Damant.—The study of marine life covers such a very broad area that you would almost need a library for the purpose of identification of specimens. Probably one of the most comprehensive books you can have would be the Micrographic Dictionary, costing £2 12s. 6d., Carpenter's "Microscope and its Revelations," edited by Dr. Dallinger, ought also to be of material assistance to you; the cost of this is 28s. Probably your best plan would be to get into communication with one of the Marine Biological Stations, from whom you could no doubt obtain particulars of the most suitable apparatus and processes. The two best microscopical societies are The Royal Microscopical Society and The Quekett Club; both of them meet at 20, Hanover Square, London, W. You would find their journals helpful. The 2″ objective would be a useful addition to your equipment. I am very much obliged for your offer to collect material.

Algæ.—A correspondent has pointed out a slip which occurred in the Algæ article last month, on page 212, column 2, paragraph 4. For "chloride of lime" read "carbonate of lime." Readers might also note that if tufts of seaweed, which are not in a growing condition, are required to be kept for any length of time, they must be preserved in strong salt water or glycerine—they will not keep long in sea-water.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. Cross, Knowledge *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

New Comet.—Mr. C. D. Perrine, of the Lick Observatory, Mount Hamilton, discovered a new comet on the morning of September 1st, about 6° S.S.E. of the variable star Algol. From computations which have been made it seems the perihelion passage will take place on November 23rd, and that the comet is approaching us and rapidly becoming brighter. Its position is exceedingly favourable for observation in the northern hemisphere. At the beginning of October the comet will be in or near the head of Cepheus, and may be readily found, as it will be tolerably conspicuous and probably visible to the naked eye. During the month named its motion will become increasingly rapid, and in a direction approximately towards the sun's place.

The following ephemeris for Greenwich midnight has been computed by Dr. D. Smart, of London, from Strömgen's parabolic elements:—

Date 1902.		R.A. H.	M.	S.	Declination. °	′	Brightness. Sep. 1 = 1
September 30	...	23	32	12	+ 57	1	16·0
October 4	...	21	22	32	52	50	22·8
,, 8	...	19	42	4	40	14	25·7
,, 12	...	18	44	24	26	4	23·2
,, 16	...	18	10	56	14	48	19·1
,, 20	...	17	49	36	6	43	15·7
,, 24	...	17	34	32	+ 0	55	13·6
,, 28	...	17	22	48	− 3	24	12 3

Tempel-Swift's Comet (1869 III.).—We may shortly expect to hear of the re-discovery of this well-known periodical comet. Its time of revolution is as nearly as possible 5½ years, for its first observed perihelion occurred on 1869, November 18, while the last took place on 1891, November 14, the comet having, in the interval of 22 years, completed four circuits of its orbit. The position of its path and length of its period are such that the object can only be observed at alternate returns to perihelion, for at its approaches to the sun in 1875, 1886, and 1897, the comet was placed on the opposite side of the sun to the earth, and therefore rendered invisible by two causes, viz., its great distance and the interference of solar light. It owes its first discovery to Tempel, at Florence, on 1869, November 27, when it was situated near the star α Pegasi, and appeared as a faint object about 2½ minutes of arc in diameter. It was re-detected by Lewis Swift at Rochester, New York, on 1880, October 10, and after a few observations had been obtained, Chandler and Schulhof pointed out the similarity of its elements with that of Tempel's comet of 1869, and inferred a period of 5½ years. This was verified by the reappearance of the comet in 1891, and it will doubtless be seen again during the ensuing autumn. Visible only as a faint telescopic object, it cannot be said to possess any specially attractive features for the observer, but astronomers regard it as a very interesting example of the Jovian family of comets, the number of which has been greatly increased in recent years, owing to the assiduity and success with which comet-seekers have pursued their labours.

Fireball of August 21, 14h.—Astronomical observers appear to have been caught napping on the early morning of Friday, August 22, when one of the most brilliant and remarkable meteors of recent years made its apparition. Apart from its unusual size, the exceptional features about it were its extreme slowness of motion, its great length of path, and the dense tail of sparks which it left behind. About twenty descriptions have come to hand from casual observers, and it may be interesting to quote some of the details:—

Mr. J. E. Sanders, Plymouth, was on board a ship abreast of Mewstone when there suddenly appeared a very bright light with a large head, which travelled at a great pace. It lit up sea and land for miles around as if it were day. Rising in the W.S.W., it travelled in an horizontal position to the E.N.E., passing 10 or 12 degrees below the moon, and leaving a long curved tail in its wake. Its duration was about 2 minutes. Mr. Sanders says that though he has been 33 years at sea, and travelled in all parts of the world, he has never seen any celestial sight comparable with that of the fireball.

Mr. J. Durston, Plymouth, was on the Hoe, and says the meteor was of great length, large head with slightly curved tail, and magnificent brilliance. It sped across the sky at a terrific rate perceptibly (to all appearance) dividing the lower strata of cloud. It was travelling from W.S.W. to E.N.E., and apparently broke up at the end, after being visible 30 seconds. First seen in azimuth, S. 71° W., and disappeared in azimuth, E. 5° S.

At St. Agnes, Cornwall, a spectator says it was first noted away in the south as a star of great brilliancy, moving very slowly round to the N.E., and disappearing at the horizon without having spent itself. It had no tail, and it kept at the same apparent altitude throughout, though it travelled a very long distance. The St. Agnes observer adds that this is doubtless "the same object as seen by Mr. Durston at Plymouth, but with this difference, that no tail was visible at St. Agnes, and that its speed was excessively slow."

Dr. Wm. Whitworth, of St. Agnes, describes it as appearing in the south and disappearing in the N.E., after traversing a most unusual length of sky. The speed was comparatively slow; the ball of fire seemed to glide rather than shoot through the air. Altitude 20° or 25°, duration 40 seconds.

"R. J. W. M.", writing from Sandquay, Dartmouth, says the meteor appeared at 2h. 5m. a.m., and travelled very steadily across the sky from W. to E. It had the aspect of a perfectly round blue ball without a tail.

R. R., Devonport, was on board a pilot boat close to the Eddystone Lighthouse when he suddenly saw an object as bright as the moon, and with an enormous tail of fire, taking an horizontal flight right across the heavens, and increasing in brilliancy in its travel until near the E. horizon, when it died out. Duration 30 seconds.

Polperro fishermen observed the meteor. It was "awfully grand and visible for a long time," passing straight across the sky from S. of the Dodman to N. of Rame Head, shooting out a tremendous number of stars along its course. "Sailors who have sailed in many seas aver they never saw anything like it before."

A Southampton correspondent alludes to the meteor as appearing over the River Test side of Southampton Water, and travelling with phenomenal slowness from W. to E. It looked like a great ball of fire, and left a very long trail of electric blue sparks in its wake.

Mr. W. H. Rowe, Leigh-on-Sea, gives the time as 14h. 2m., and says he watched the fireball pass from S. 15° W., altitude 8°, to S. 67° E., altitude 8°. Diameter ⅓th that of moon. Tail of brilliant fragments, dying out 2° from the nucleus Duration 30 to 35 seconds.

Mr. C. F. Dowsett, Basingstoke, says the fireball passed in a straight line from W. to E. Portions seemed to descend from it, while the larger part continued its flight. It appeared travelling at the same rate as a train making 40 miles an hour. The position where he lost sight of it was a little S. of E.

Messrs. Blythe and Shorney, Tamworth, near Birmingham, describe the meteor as leaving few sparks behind it. It moved horizontally and very slowly towards the E.

At Sidcup, Eltham, it was very brilliant; travelled quite slowly in an horizontal path. Duration probably half a minute.

At London it passed from west to east across the sky, and its direction was parallel with the horizon. Its duration of flight was half a minute, and it developed a tail like that of a comet. Three Australian troopers, who were standing at Hyde Park Corner, say it appeared to travel horizontally towards the S., that it was visible about 3 minutes, and had a long tail.

From these and a few other accounts, which are not, however, very definite and satisfactory, the following approximate real path has been derived:—

Height at beginning	...	59 miles over a point in lat. 47½° N., long. 9½° W.
Height at ending	...	27 miles over a point in lat. 50½° N., long. 4° E., near St. Omer, France.
Length of path	...	611 miles.
Velocity	...	15½ miles per second.
Radiant point	...	283° – 10½° low on W.S.W. horizon.

The fireball traversed the whole length of the English Channel, and in a direction from W.S.W. to E.N.E., nearly parallel with the south coast of England. The observed path was abnormally long. The velocity is obtained by adopting 40 seconds as the whole duration. The observations furnish some contradictions, and it seems impossible to deduce any very exact results from them.

THE FACE OF THE SKY FOR OCTOBER.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the sun rises at 6.1 and sets at 5.39; on the 31st he rises at 6.52 and sets at 4.35.

The sun rises partially eclipsed on the 31st, the eclipse ending at 7.1, only nine minutes after sunrise.

The Moon:—

	Phases.	h. m.
Oct. 1	● New Moon	5 9 P.M.
„ 9	☽ First Quarter	5 21 P.M.
„ 17	○ Full Moon	6 1 A.M.
„ 23	☾ Last Quarter	10 58 P.M.
„ 31	● New Moon	8 14 A.M.

The moon is in apogee on the 8th, and in perigee on the 20th.

An eclipse of the moon takes place on the morning of the 17th, the earlier phases of which are visible from this country, but the moon sets at Greenwich at 6.32 A.M., totally eclipsed. In America, however, the whole phenomenon will be observable.

Further particulars of the eclipse, and a diagram showing the path of the moon through the shadow, are given in another column.

Occultations:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
			h. m.	°	°		°	°	d. h.
Oct. 12	c^2 Capricorni	6·2	9 48 P.M.	70	55	11 2 P.M.	243	217	11 5
„ 16	ζ^1 Piscium	4·2	10 17 P.M.	100	116	11 18 P.M.	213	216	15 6
„ 20	δ^1 Tauri	4·0	5 8 A.M.	84	51	6 13 A.M.	270	231	18 12
„ 20	δ^2 Tauri	4·7	5 43 A.M.	108	71	6 43 A.M.	247	207	18 12
„ 23	λ Geminorum	3·6	0 53 A.M.	58	98	1 44 A.M.	311	349	21 8

The Planets.—Mercury is too near the sun for observation at the beginning of the month, being in inferior conjunction on the 19th. During the last week of the month, however, he is fairly well placed, rising about 1½ hours in advance of the sun. He is near Spica on the 22nd, and Venus on the 23rd.

Venus is a morning star in Virgo, and rises about an hour before the sun. She is near Spica Virginis on the 24th. About the middle of the month 0·98 of her disc is illuminated.

Mars is a morning star in Leo, rising about 1 A.M. He is near the star Regulus on the 21st. His apparent diameter is increasing, being about 5″·0, whilst 0·93 of his disc is illuminated.

Jupiter is the most conspicuous object in the evening sky, and is so bright that it can be discerned long before it is dark. Near the middle of the month the planet is on the meridian about 7 P.M., and sets at 11.30 P.M.; his apparent diameter is decreasing, being now about 39″. The retrograde movement of the planet ends on the 4th, when he is stationary, after which his motion will be direct or easterly. On the evening of the 11th he will be near the moon. The more interesting phenomena of the satellites which may be observed are as follows:—

		h. m.			h. m.
2nd.—	II. Tr. I. ...	5 36	21st.—	I. Tr. I. ...	5 38
	IV. Ec. R. ...	7 4		I. Sh. I. ...	6 58
	II. Sh. I. ...	7 59		I. Tr. E. ...	7 59
	II. Tr. E. ...	8 33		I. Sh. E. ...	9 18
	II. Sh. E. ...	10 55	27th.—	II. Sh. I. ...	5 6
5th.—	III. Sh. E. ...	6 56		II. Tr. E. ...	5 20
	I. Tr. I. ...	7 25		IV. Sh. I. ...	6 29
	I. Sh. I. ..	8 37		II. Sh. E. ...	8 2
	I. Tr. E. ...	9 45		I. Oc. D. ...	10 24
	I. Sh. E. ...	10 58	28th.—	I. Tr. I. ...	7 33
19th.—	III. Tr. I. ...	5 58		I. Sh. I. ...	8 53
	III. Tr. E. ...	9 40		I. Tr. E. ...	9 53

Saturn is about 16 degrees west of Jupiter, and souths at the middle of the month at 6 P.M., setting at 10 P.M. The planet is in quadrature with the sun on the 15th. On the 7th the apparent outer major and minor axis of the ring are 39″·27 and 15″·64 respectively, while the polar diameter of the ball is 15″·6. The ring is widely open.

Uranus is too near the sun for observation.

Neptune may be observed before midnight throughout the month, rising on the 1st about 9.30 P.M., and on the 31st about 7.30 P.M. The planet is near to μ Geminorum, and should appear in the same field of view as the star throughout the month, if observed with a low power eyepiece. Their positions are as follows:—

	R. A.	Declination.
Neptune (Oct. 8th)	6h. 16m. 6s.	N. 22° 16′ 27″.
μ Geminorum ...	6h. 17m. 5s.	N. 22° 33′ 42″.

The Stars.—About 9 P.M. at the middle of the month, the following constellations may be observed:—

Zenith	Cygnus, Cepheus, Cassiopeia.
South	Pegasus, Aquarius, Capricornus, *Fomalhaut*.
West	Lyra, Hercules, Ophiuchus, Corona; Boötes to the N.W.; Aquila to the S.W.
East	Andromeda, Aries, Perseus, Pleiades; Aurigae to the N.E.; Cetus to the S.E.
North	Ursa Major, Ursa Minor, Draco.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of September Problems.

No. 13.

Key-move.—1. Kt to KKt 5.

If 1. . . . P to Kt6, etc,	2. Q to B2, etc.
1. . . . B to B3,	2. Q to Kt3ch, etc.
1. . . . Kt to B6,	2. Kt to B7ch, etc.
1. . . . K to Q3,	2. Q to B8ch, etc.
1. . . . K to Q5,	2. Kt to K6ch, etc.

[More than one solver has been deceived by the "try," 1. Kt to B5. The only defence is Kt to B8. There is a dual after 1. . . . K to Q3, by 2. Q to K3.]

XUM

No. 14.

Key-move.—1. Q to KB8.

If 1. . . . K to Q4,	2. Q to B5ch, etc.
1. . . . K to K3,	2. Kt to B4ch, etc.
1. . . . B to K3,	2. Q to B3, etc.
1. . . . B to B2,	2. Q × B, etc.
1. . . . P to Q4,	2. Q to K7ch, etc.
1. . . . Anything else,	2. Q to KB5, mate.

No. 15.

There appears to be no solution, the author's intention (1. Q to QKt8) being defeated by 1. . . . P to QKt8.

SOLUTIONS received from W. Nash, 5, 4, 4; Alpha, 0, 4, 0; W. Jay, 5, 4, 4; G. Woodcock, 4, 4, 0; G. W. Middleton, 5, 0, 0; W. de P. Crousaz, 0, 4, 0; "Tamen," 4, 0, 0; C. Johnston, 0, 4, 4; "Looker-on," 5, 4, 4; J. W. Dawson, 3, 4, 4.

Tamen.—As you say, your solution of No. 14 was just too late to score.

G. Woodcock and *Alpha.*—In No. 15, 1. Q × P is met by 1. . . . R to Q4.

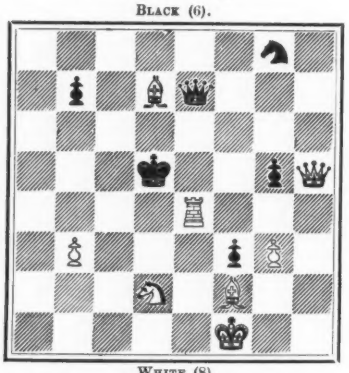
Note.—Failure in the case of No. 15 is no disqualification for taking part in the judging of the sound problems. Nevertheless I expect to extend the list to those who fail not more than twice in the case of sound problems.

PROBLEMS.

No. 16.

"Without hope."

BLACK (6).



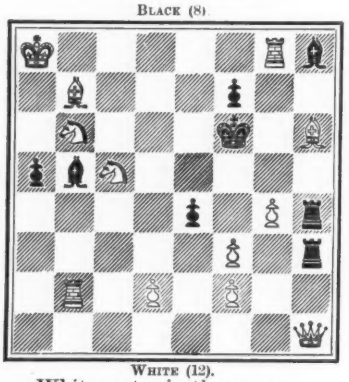
WHITE (8).

White mates in three moves.

No. 17.

"Brutum Fulmen."

BLACK (8)



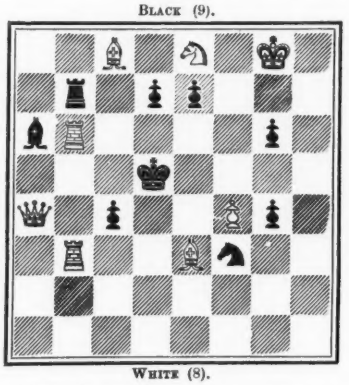
WHITE (12).

White mates in three moves.

No. 18.

"Bargany."

BLACK (9).



WHITE (8).

White mates in three moves.

CHESS INTELLIGENCE.

The Newnes Challenge Cup, which carries with it the Amateur Championship of the long defunct British Chess Association, was competed for at the Southern Counties' Tournament, held at Norwich last month. Mr. H. E. Atkins, who has held the cup for some years, did not defend his title, and the winner proved to be Mr. R. P. Michell, the well-known London amateur. The other competitors included Dr. Dunstan, and Messrs. Blake, Jacobs, Mortimer, Sherrard, Wainwright, F. Brown, Loman, and R. F. B. Jones.

The final tie for the Championship of the S. C. C. U. resulted in a fiasco, Gloucestershire, who were looked upon as almost certain winners, after the defeat of Surrey, being unable to raise a team during the holiday season. The result was that Norfolk, the winners of the North-Eastern Section, became the Champion County.

The death is announced of Mr. E. B. Schwann, the well-known player and problem-composer. Mr. Schwann was acting as Hon. Sec. to the delegates of the counties who were recently attempting the formation of a National Chess Federation.

Owing to the postponement of the World's Fair, the Seventh American Chess Congress, which was to have been held next year, has been put off till 1904.

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